SECTION 5

TRANSMITTER MAINTENANCE

5-1. GENERAL. This section contains essential information for alignment and neutralizing procedures. The Transmitter is properly aligned and tested before shipment. Should the Transmitter require adjustment, or realignment, loosen two screws at the sides and lift the top lid on its rear hinge. This allows access to the top of the chassis where most of the adjustments will be made. To remove the Transmitter from the case loosen the screws holding the rubber feet and lift the chassis clear.

5-2. EQUIPMENT REQUIRED. Equipment, or equivalent, required for adjustment and realignment of the Transmitter is as follows:

a. VTVM with RF probe, Hewlett-Packard, 410B.

b. Signal generator, Hewlett-Packard, 606A.

c. Multimeter, 20,000 ohm per volt, Simpson 260.

d. 50 ohm, 100 watt, dummy load.

e. Prepare a swamping tool with two alligator clips, a 100 ohm resistor and a 0.01MFD capacitor. Connect the resistor and capacitor in series and solder the alligator clips to the loose ends.

WARNING

> The power amplifier plate voltage in the Transmitter may be fatal. Always disconnect the high voltage leads from the Power Supply when making adjustments. If it is necessary to make adjustments with the high voltage connected, observe all high voltage precautions. Never make high voltage adjustments unless a second person capable of rendering aid is close by.

5-3. PRELIMINARY PROCEDURES. Carry out the following preliminary procedures:

a. Make certain XMITR switch SW4 on the Control Unit is in the off (down) position.

b. Position the operating controls as follows:

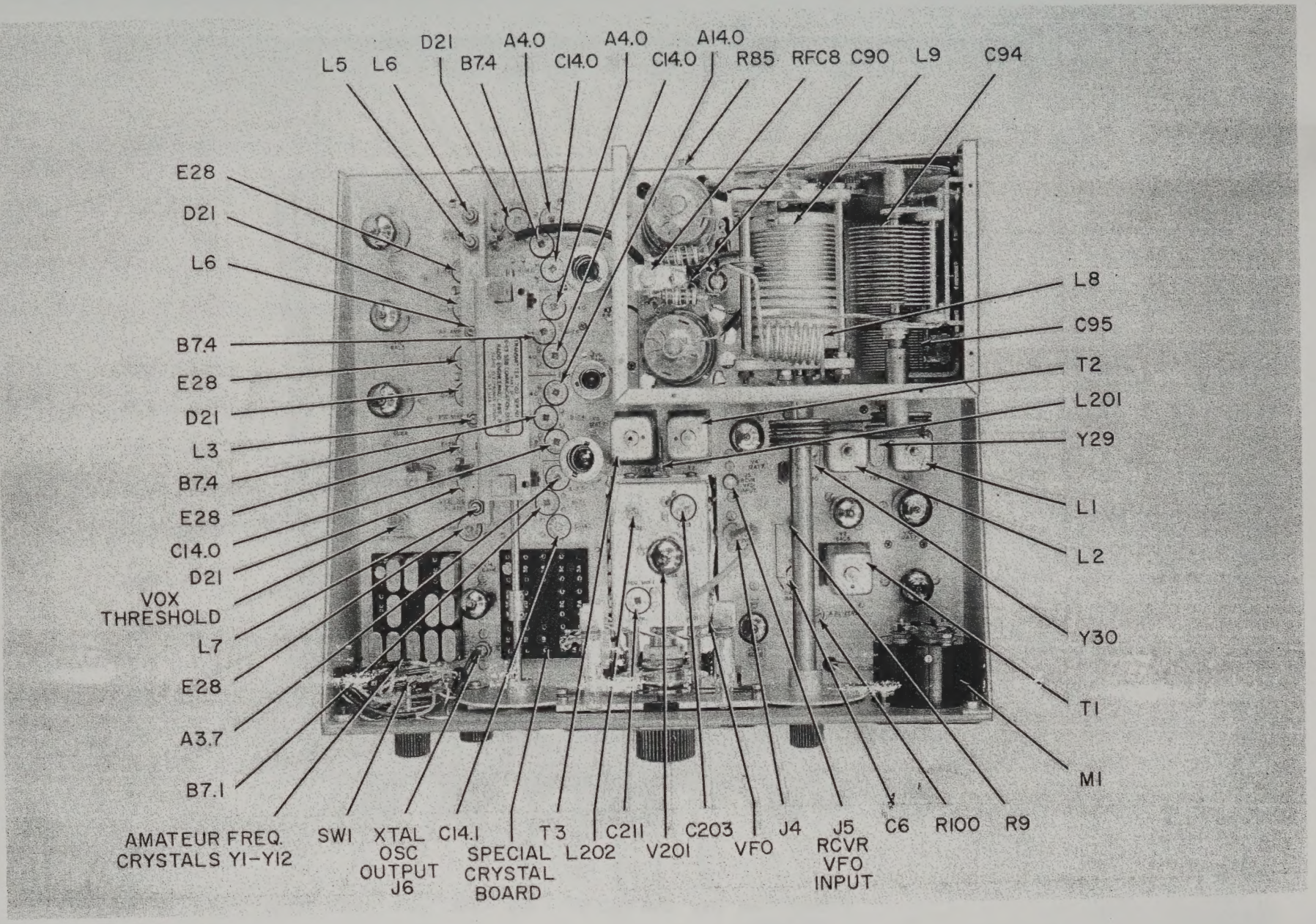

Figure 5-1. T-102 Transmitter - Top View

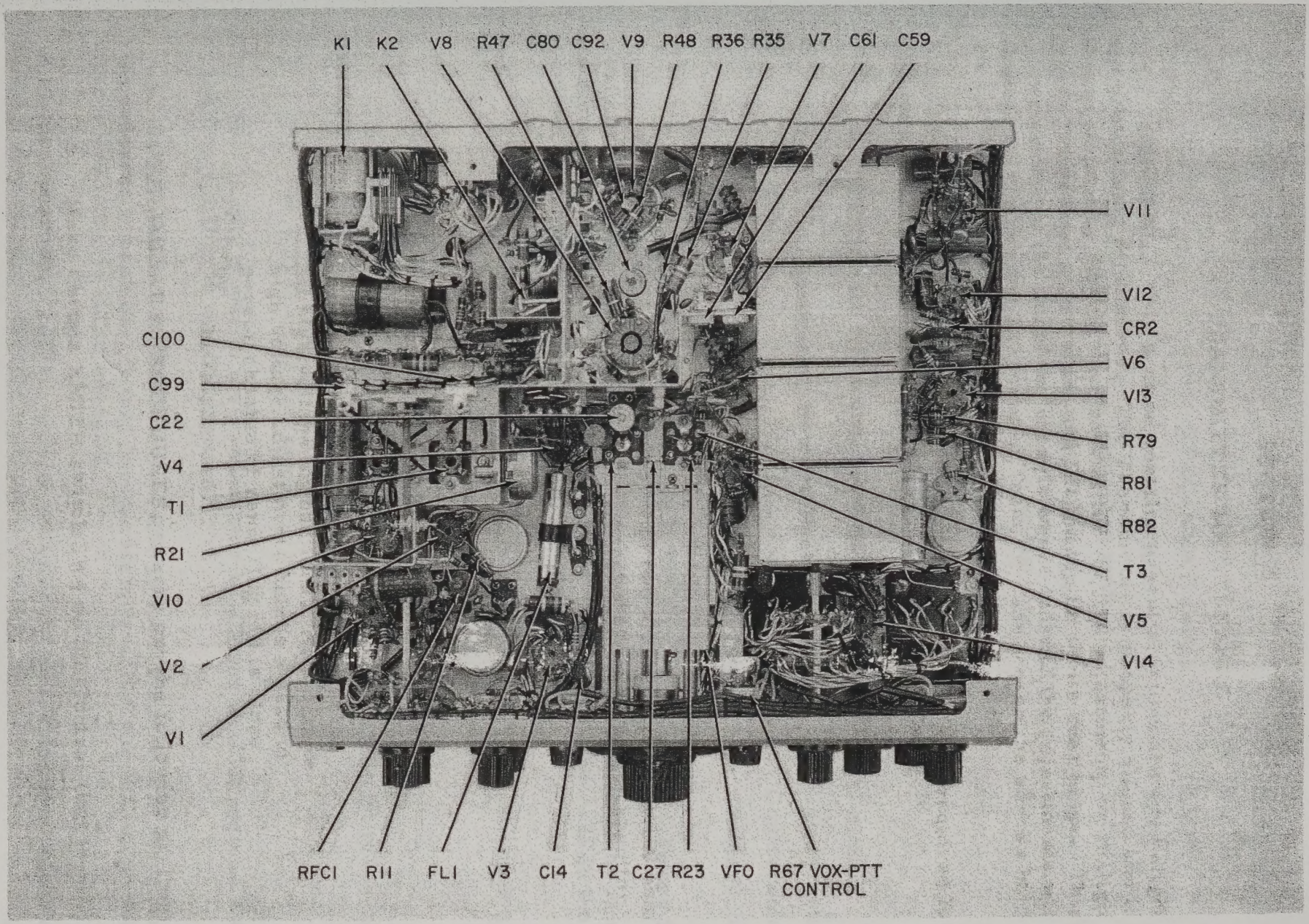

Figure 5-2. T-102 Transmitter - Bottom View

Reference No.	Control	Position
SW1	VFO switch	XMTR
SW2	SPEC-AMAT switch	AMAT
SW3	BAND switch	28A
SW4	Emission switch	TUNE
SW5	METER switch	GRID
L201	Main tuning control	0
L3, L4, L5, L6, L7	EXCITER TUNING control	28
L9, C94	PLATE tuning control	28
C95	LOADING lever	5 o'clock
R67	VOX-PTT control	Counter-clockwise
R60	QT control	Counter-clockwise
R8	MOD LEVEL control	Counter-clockwise

c. Disconnect the high voltage +800V connector from the Power Supply.

d. Disable the screen circuit of the power amplifier tubes by removing the bare wire jumper from the junction of R47 and R48 (figure 5-2) on the terminal board adjacent to the 6146 tube sockets.

5-4. 455KC ALIGNMENT PROCEDURES. (See figure 5-2.) Proceed as follows:

a. Place operating controls as indicated in paragraph 5-3.

b. Connect the RF probe of the VTVM across C14 (input to mechanical filter FL1).

c. Set VTVM on 10 volt scale.

d. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

e. Advance VOX-PTT control R67 to approximately midrange until VOX relay K1 energizes. It may be necessary to adjust the VOX threshold control R70 to cause K1 to energize.

f. With MOD LEVEL control R8 fully counter-clockwise, observe VTVM. Any voltage indicated is due to a carrier.

g. Adjust CARRIER BALANCE resistor R9 (figure 5-1) for minimum VTVM readings.

h. Advance MOD LEVEL control R8 until VTVM indicates one volt.

i. Turn the top and bottom screws of T1 (figures 5-1 and 5-2) for maximum voltage on the VTVM.

j. Disconnect the RF probe of the VTVM.

CAUTION

Do not adjust L1, C99 or L2, C100. These parts are factory adjusted.

k. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-5. BAND PASS IF ALIGNMENT. (See figure 5-2.) To align the bandpass IF circuit, proceed as follows:

a. Place operating controls as indicated in paragraph 5-3 except for VFO switch SW1 which should be placed in RCVR position.

b. Connect the signal generator between pin 7 of V4, first balanced mixer, and ground.

c. Connect RF probe of VTVM at junction of C27 and R23.

d. Set VTVM at 5 volts.

e. Tune signal generator to 2.955MC.

f. Connect the swamping tool (paragraph 5-2, step e) between ground and the output of T2.

g. Apply power to the Transmitter by placing XMITR switch SW4 on Control Unit to the ON position.

h. Keep VTVM indication at about 0.5 volts by adjusting the signal generator output.

i. Peak the primary (bottom slug) of T2, and peak T3 (bottom slug).

j. Remove the swamping tool from between ground and the output of T2, and connect it from pin 1 to pin 6 of V4.

k. Peak the secondary of T2 (top slug) and peak T3 (top slug). (See figure 5-1.)

l. Remove the swamping tool and RF probe.

m. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-6. RF CIRCUITS ALIGNMENT. To align the RF circuits proceed as follows:

a. Place the operating controls as indicated in paragraph 5-3.

b. To align the EXCITER TUNING control mechanically proceed as follows:

1. Set the EXCITER TUNING control to 7MC.

2. Align the tops of the iron cores in L3, L4, L5, L6 and L7 with the tops of the coil forms by spline driver adjustments on the EXCITER TUNING control slug rack. Set the rear tuning core four turns further in than the top of its coil form.

3. Readjust the EXCITER TUNING control to the low frequency end of the 28MC band.

c. Connect RF probe of VTVM to pin 5 of V9 and ground.

d. Set VTVM at 10 volts.

e. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

f. Advance MOD LEVEL control R8 until VTVM gives an indication.

g. Set VTVM to 50 volt scale.

h. Peak the trimmers marked E-28 (DRIVER PLATE, RF AMP PLATE, 2ND MIXER PLATE) for maximum VTVM reading. Keep indication on VTVM below 30 volts by adjusting MOD LEVEL control R8.

CAUTION

Take care not to adjust the RF tuning to the HF crystal oscillator frequency. When this occurs, the indicated output on the VTVM cannot be adjusted by the MOD LEVEL control R8.

i. Remove the RF probe from pin 5 of V9.

j. Repeak the E-28 DRIVER PLATE circuit trimmer using the meter (Transmitter) as an indicator.

k. Replace the RF probe of VTVM at pin 5 of V9 and ground.

l. Place EXCITER TUNING control to 21.0MC (lower edge of 15 meter band).

m. Set BAND switch SW3 to 21.0MC.

n. Peak the trimmers marked D-21 (DRIVER PLATE, RF AMP PLATE, 2ND MIXER PLATE) for maximum indication on the VTVM. Adjust MOD LEVEL control R8 to keep voltage below 30.

o. Remove the RF probe from pin 5 of V9, then repeak the driver plate circuit trimmer D-21 using the meter (Transmitter) as a peak indicator.

p. Restore the RF probe of VTVM to pin 5 of V9.

q. Turn EXCITER TUNING control to 14.0MC (lower edge of 20 meter band).

r. Set BAND switch SW3 to 14.0MC.

s. Peak the trimmers marked C-14.0 (DRIVER PLATE, RF AMP PLATE, 2ND MIXER PLATE) for maximum indication on the VTVM. Adjust MOD LEVEL control R8 to keep voltage below 30 volts.

t. Remove the RF probe from pin 5 of V9, then repeak the DRIVER PLATE trimmer C-14.0 using the meter (Transmitter) as an indicator.

u. Restore the RF probe of the VTVM to pin 5 of V9.

v. Turn EXCITER TUNING control to the upper end of the 40 meter band at 7.4MC on the EXCITER TUNING dial.

w. Place BAND switch SW3 to 7.2MC, and set main tuning dial to 200.

x. Peak the driver plate trimmers marked B-7.4 (DRIVER PLATE, RF AMP PLATE, 2ND MIXER PLATE) for maximum indication on the VTVM. Adjust MOD LEVEL control R8 to keep voltage below 30 volts.

y. Remove the RF probe from pin 5 of V9, then repeak the DRIVER PLATE trimmer B-7.4 using the meter (Transmitter) as an indicator.

z. Replace the RF probe connection to pin 5 of V9.

aa. Set EXCITER TUNING control to 4.0MC (upper end of the 80 meter band).

ab. Set BAND switch SW3 to 3.8MC and turn the main tuning dial to 200.

ac. Peak the trimmers marked A-4.0 (DRIVER PLATE, RF AMP PLATE, 2ND MIXER PLATE) for maximum voltage on the VTVM. Adjust MOD LEVEL control R8 to keep the voltage below 30.

ad. Remove RF probe from pin 5 of V9, then repeak the DRIVER PLATE trimmer A-4.0, using the meter (Transmitter) as an indicator.

ae. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-7. HF CRYSTAL OSCILLATOR ALIGNMENT. Proceed as follows:

a. Place the operating controls as indicated in paragraph 5-3, except as follows:

Reference No.	Control	Position
L201	Main tuning control	100

b. Peak the grid current by adjusting the EXCITER TUNING control and observing the meter (Transmitter).

c. If necessary, increase MOD LEVEL control R8 to obtain grid current indication.

d. Tune trimmer E-28 XTAL OSC PLATE for maximum grid current.

e. Set BAND switch SW3 to 21.2MC.

f. Adjust EXCITER TUNING control for peak grid current reading on the meter (Transmitter).

g. Tune trimmer D-21 XTAL OSC PLATE for maximum grid current.

h. Repeat steps b through g for BAND switch SW3 settings of 14.0MC, 7.0MC and 3.6MC.

i. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-8. POWER AMPLIFIER NEUTRALIZATION. The power amplifier can be neutralized using a Receiver S meter as the indicator. If a Receiver is used, couple a small pick-up loop between the Transmitter RF output and the Receiver input. For neutralizing, the Transmitter dummy load can be a 50 ohm, 1 watt resistor. The following procedures provide for the use of the VTVM as an indicator.

a. Place operating controls as indicated in paragraph 5-3, except as follows:

Reference No.	Control	Position
SW3	BAND switch	14.0MC
SW4	Emission switch	LOCK KEY
L3, L4, L5, L6, L7	EXCITER TUNING control	14MC

b. Remove the coaxial connector at RF OUT jack J1B and connect the 50 ohm, one watt carbon resistor.

c. Remove the cover of the power amplifier shielded compartment by loosening 10 screws.

d. Connect the RF probe of VTVM to the top of the plate choke coil RFC8. (See figure 5-1).

e. Set the VTVM to the lowest voltage scale.

f. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

g. Advance MOD LEVEL control R8 slightly.

h. Adjust EXCITER TUNING control and MOD LEVEL control R8 for peak reading on the VTVM. Keep this reading below 0.5 volt.

i. Turn off power to the Transmitter and turn the chassis over.

j. Turn on power and adjust PA neutralizing capacitor C80, located between the PA tubes on the underside of the chassis, for voltage dip on VTVM.

k. Remove the RF probe from RFC8, and replace the power amplifier compartment cover.

NOTE

If using the Receiver for this indication be sure to keep the MOD LEVEL control R8 (Transmitter) low and the coupling loose, to prevent damage to the Receiver.

1. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-9. DRIVER NEUTRALIZATION. To neurra ize the driver tube stage, proceed as follows:

CAUTION

In this process the 800 volts DC is connected to the PA plates. Use extreme caution when high voltages are present.

NOTE

If Receiver S meter is used as an indicator turn Receiver BAND switch SW1 to 14.0MC.

a. Place the operating controls as indicated in paragraph 5-3, except as follows:

Reference No.	Control	Position
SW3	BAND switch	14.0MC
SW4	Emission switch	LOCK KEY
SW5	METER switch	PL

b. Connect the high voltage plate supply by restoring the high voltage cable to the +800 volt Power Supply terminal.

c. Connect the bare jumper wire to the junction of R47 and R48 on the terminal board. This restores voltage to the PA screen circuit. (See figure 5-2.)

d. Remove plate and screen voltages from the driver tube by unsoldering the jumper wire which connects to the feedthru at the junction of R35 and R36. (See figure 5-2.)

e. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

f. Connect RF probe across the antenna dummy load.

g. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

h. Advance VOX-PTT control R67 until the VOX relay closes.

i. Adjust BIAS ADJ. R85 on the rear apron of the chassis for a plate current reading of 37MA on the meter (Transmitter).

j. Increase MOD LEVEL control R8 setting. Adjust EXCITER TUNING and PLATE tuning controls to 14.0MC for maximum reading on the VTVM. The VTVM should read 0.3 volts. (If the Receiver S meter is used, adjust for maximum reading on the S meter (Receiver).

k. Adjust the driver neutralizer capacitor C59 (figure 5-2) for a voltage dip.

l. Turn off power to the Transmitter, and disconnect Receiver pick up loop and VTVM probe.

m. Restore the driver screen voltage to the power amplifier tubes by resoldering the screen supply at the junction of R35 and R36, which was removed in step d.

n. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-10. FEEDBACK NEUTRALIZATION. Keep output power as low as possible at all times, but sufficient to obtain a meter (Transmitter) reading.

a. Set the operating controls as follows:

Reference No.	Control	Position
R8	MOD LEVEL control	Fully counter-clockwise
SW1	VFO switch	XMTR
SW4	Emission switch	TUNE
SW3	BAND switch	28A
SW5	METER switch	PL
	Main tuning dial	100

b. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

c. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

d. Turn the EXCITER TUNING control until the meter (Transmitter) peaks.

e. Turn the PLATE tuning control for a dip in the meter (Transmitter) reading.

f. Place emission switch SW4 in the LOCK KEY position and repeat steps d and e for sharper tuning.

g. Turn off power and turn chassis over Locate the feedback neutralizing capacitor C61 (See figure 5-2.)

h. Turn on power to the Transmitter and adjust C61 until the meter (Transmitter) dip and the power output peak coincide while tuning the PLATE tuning control to resonance.

i. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-11. VFO SIDEBAND FREQUENCY SHIFT ADJUST. To adjust the VFO sideband shift, an accurate Receiver is required. Proceed as follows:

NOTE

Do not make this adjustment unless shifting from one sideband to the other. Retuning is necessary.

Each time the steps in this paragraph are performed, it must be followed with paragraph 5-12.

a. Place the operating controls as indicated in paragraph 5-3, except as follows:

Reference No.	Control	Position
SW3	BAND switch	14.0MC
SW4	Emission swi...	LSB
SW5	METER switch	PL
L201	Main tuning dial	100
R9	CARRIER BALANCE control	Clockwise

b. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

c. Apply power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the ON position.

d. Adjust EXCITER TUNING control for maximum reading on the meter (Transmitter).

e. Dip the meter (Transmitter) by adjusting the PLATE tuning control.

f. Tune the Receiver to zero beat with the Transmitter.

g. Shift emission switch SW4 from LSB to USB.

h. Adjust trimmer capacitor C203 to zero beat with the Receiver. (See figure 5-1.)

i. Turn off power to the Transmitter by placing XMITR switch SW4 on the Control Unit to the off (down) position.

5-12. CARRIER BALANCE ADJUSTMENT. Adjust the CARRIER BALANCE R9 as follows: (See figure 5-1.)

a. Set BAND switch SW3 to 14.0MC.

b. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

c. Tune and load the Transmitter keeping the power output as low as possible to produce a reading.

d. Place emission switch SW4 to LSB.

e. Set MOD LEVEL control R8 fully counter-clockwise.

f. Connect the RF probe across the dummy load. Set VTVM to lowest voltage scale. If a Receiver is used, couple a small pick-up loop from Receiver RF input to the dummy load.

g. Turn VOX-PTT control R67 fully counter-clockwise until the PTT switch is heard to click.

h. Press the push-to-talk microphone button and observe VTVM. Reading should be less than 0.22 volts. If the VTVM indicates a greater voltage than this amount proceed to steps i and j.

i. Adjust CARRIER BALANCE R9 and C6 until the VTVM registers below 0.22 volt or the S meter (Receiver) indicates minimum. It may require several adjustments of these two components (since one interacts with the other), until further adjustment does not produce a decreased voltage reading.

j. Shut off power to the Transmitter. Remove VTVM, RF probe and dummy load.

5-13. APL ZERO ADJUSTMENT. The APL zero adjustment is made to set the zero level at which the Automatic Peak Limiting indicator (Transmitter meter) operates, proceed as follows:

a. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

b. Place emission switch SW4 on TUNE and advance VOX-PTT control R67 until plate current is indicated.

c. Tune and load the Transmitter at 14.1 MC.

d. Rotate MOD LEVEL control R8 fully counter-clockwise.

e. Set METER switch SW5 to APL and emission switch SW4 to LOCK KEY.

f. Adjust A.P.L. ZERO on chassis until meter (Transmitter) reads zero.

5-14. FIRST MIXER BALANCE ADJUSTMENT. (See figure 5-2.) To adjust the first mixer balance to produce the greatest carrier reduction, proceed as follows:

a. Connect a 50 ohm, 100 watt dummy load to RF OUT jack J1B.

b. Tune Transmitter to 14.1MC.

c. Couple a Receiver loosely to the Transmitter and tune slowly across 14.555MC until the transmitted signal on 14.1MC is heard.

d. Adjust R21 (1st mixer balance potentiometer) and C22. These components may require several adjustments until the signal heard in the Receiver has about disappeared, or until further adjustment does not produce any appreciable drop in signal strength.

5-15. VARIABLE FREQUENCY OSCILLATOR (VFO). The variable frequency oscillator is a linear calibrated permeability tuned oscillator with a range of 2.4MC to 2.6MC. The frequency of the VFO is read on two dials.

The main tuning dial is divided into 10KC segments and the vernier dial is divided into 1KC segments. Tuning is linear within 300 cycles at any dial point. The VFO is factory aligned and adjusted; and ordinarily does not require re-adjustments. If parts replacement is necessary, be certain to obtain only those components listed in the VFO parts list.

SECTION 6

TRANSMITTER REFERENCE MATERIAL

6-1. GENERAL. The voltage and resistance charts, parts list, and the schematic diagram (figure 6-1) for the T-102 Transmitter are provided in this section. Reference material for the M-136 Variable Frequency Oscillator is also included.

6-2. T-102 TRANSMITTER RESISTANCE MEASUREMENT CHART. (See figure 6-2.) Resistance measurements were made with a multimeter (20,000 ohms per volt) with the power cables disconnected and the front panel controls placed as follows:

CAUTION

Remove all input source power from Transmitter.

Reference No.	Control	Position
R8	MOD LEVEL control	Fully counter-clockwise
	Main tuning dial	100
	EXCITER TUNING dial	7.0
SW2	SPEC-AMAT switch	AMAT
R67	VOX-PTT control	Fully counter-clockwise PTT switch off
SW3	BAND switch	1B-7.0
R60	QT control	Fully counter-clockwise
SW5	METER switch	PL
	PLATE tuning dial	7.1
SW4	Emission switch	LOCK KEY

All measurements were made with the tubes in their sockets. Any resistance reading within 20% is considered satisfactory. When required, VOX relay K1 is energized by hand.

6-3. M-136 VFO RESISTANCE MEASUREMENT CHART. (See figure 6-3.) Resistance measurements were made with tube V-20 removed from its socket and all power turned off. Measurements were made with a multimeter (20,000 ohms per volt).

CAUTION

Remove all input source power from VFO.

NOTE

Any resistance measurement within 20% of listed value is considered satisfactory.

6-4. T-102 TRANSMITTER DC VOLTAGE CHART. (See figure 6-4.) Voltage measurements were conducted with the equipment operating in a normal fashion, using a multimeter (20,000 ohms per volt.) Modes and conditions encountered are shown in the columns where necessary to effect a proper reading. The front panel controls were positioned as follows:

Reference No.	Control	Position
R8	MOD LEVEL control	mid-range
C95	LOADING lever	mid-range
SW2	SPEC-AMAT switch	AMAT
SW3	BAND switch	1B-7.0
	Main tuning dial	100
R60	QT	Fully clockwise
SW5	METER switch	PL

Reference No.(Cont)	Control	Position
R67	VOX-PTT control	Mid-range and fully clockwise where indicated
SW4	Emission switch	LOCK KEY

6-5. T-102 TRANSMITTER AF, RF VOLTAGE CHART. (See figure 6-5.) Audio and radio frequency voltage measurements were conducted with the Transmitter operating under the following conditions:

a. Connect VTVM with RF probe across antenna 50Ω dummy load.

b. Place METER switch SW5 to PL.

c. Tune and load Transmitter slowly on 7.0MC.

d. Observe VTVM and adjust MOD LEVEL control R8 until meter (Transmitter) reads 70.7 volts RMS.

e. Shift METER switch SW5 to GRID.

f. Adjust MOD LEVEL control R8 until meter (Transmitter) M1 indicates zero and VTVM is about 50 volts RMS.

g. Place Transmitter controls to following positions.

Reference No.	Control	Position
SW4	Emission switch	LOCK KEY
SW3	BAND switch	1B-7.0
	Main tuning dial	100
R67	VOX-PTT control	Mid-range and as indicated on chart
R60	QT control	Fully counter-clockwise
SW5	METER switch	PL then GRID (Steps b and e)
	PLATE tuning dial	7.1
SW1	VFO switch	XMTR

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Top Cap
V-1 608-A	17KΩ	42KΩ	450K Mode in USB	.1	.1	150KΩ Mode in USB	1000	1000	80KΩ	-
V-2 6AL5	0	0	.1	.1	INF	0	INF	-	-	-
V-3 6DC6	300K	150	.1	.1	30K	19K	S.C.	-	-	-
V-4 12AT7	13K	42K Relay Closed	950	.1	.1	13K	42K Relay Closed	950	.1	-
V-5 12AT7	15K	36Ω	240	.1	.1	15K	110K	240	.1	-
V-6 6AH6	250K	S.C.	.2	.2	14K	130K	430	-	-	-
V-7 12BY7	150	14K Relay Closed	S.C.	.1	.1	.1	12K	36K	S.C.	-

Figure 6-2. T-102 Transmitter Resistance Measurement Chart (Sheet 1 of 2)

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V-201 6U8A	150KΩ	70KΩ	150KΩ	1.4Ω	0	150KΩ	16.5Ω	350Ω	80KΩ

Figure 6-3. M-136 VFO Resistance Measurement Chart

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Top Cap
V-1 6U8-A	205	Mode USB 0	66 Mode USB	Fil.	Fil.	80 Mode USB	1.4 Mode USB	4.4	0	-
V-2 6AL5	Grd	Grd	Fil.	Fil.	-.02	Grd	-.02	-	-	-
V-3 6DC6	0	+.92	Fil.	Fil.	180	88V	Grd	-	-	-
V-4 12AT7	210	-.7	5.6	Fil.	Fil.	210	-.7	5.6	Fil.	-
	VOX ADVANCED UNTIL RELAYS CLOSE									
V-5 12AT7	240	0	+2.6	Fil.	Fil.	240	-2.3	+1.2	Fil.	-
V-6 6AH6	0	Grd	Fil.	Fil.	240	140	2.5	-	-	-
V-7 12BY7	+3.4	0	Grd	Fil.	Fil.	Fil.	290	195	Grd	-
	VOX ADVANCED UNTIL RELAYS CLOSE									
V-8 6146	.14	Fil.	290	.14	-65	.14	Fil.	Grd	-	815
	VOX ADVANCED UNTIL RELAYS CLOSE									

Figure 6-4. T-102 Transmitter DC Voltage Chart (Sheet 1 of 2)

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Top Cap
V-9 6146	.14	Fil.	290	.14	-65	.14	Fil.	Grd	-	815
		VOX ADVANCED UNTIL RELAYS CLOSE								
V-10 12AT7	125	-1.35	.17	Fil.	Fil.	180	-.16	1.8	Fil.	-
V-11 12AT7	130	0	2.8	Fil.	Fil.	180	0	2.4	Fil.	-
		VOX ADVANCED UNTIL RELAYS CLOSE								
V-12 6AL5	+1.2	-12	Fil.	Fil.	+1	Grd	+1	-	-	-
		VOX ADVANCED UNTIL RELAYS CLOSE								
V-13 6U8A	175	0	71	Fil.	Fil.	175	2	4	Fil.	-
		VOX ADVANCED UNTIL RELAYS CLOSE								
V-14 6AH6	-1.1	Grd	Fil.	Fil.	290	180	7.4	-	-	-

Figure 6-4. T-102 Transmitter DC. Voltage Chart (Sheet 2 of 2)

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Top Cap
V-1 6U8-A	- .01V	less than WITH VOX SET TO MINIMUM (PTT OFF)	-	-	-	1.8V	-	.01	.02	-
V-2 6AL5	-	- WITH VOX SET TO MIN (PTT OFF)	-	-	14	-	14	-	-	-
V-3 6DC6	less than .01	- WITH VOX SET TO MIN (PTT OFF)	-	-	48	-	-	-	-	-
V-4 12AT7	2.5	5.0 AMAT - SPEC SW SET TO SPEC (LESS XTAL)	-	-	-	2.5	5.0	-	-	-
V-5 12AT7	2.2	.07	2.6	-	-	2.2	2.6	-	-	-
V-6 6AH6	.1 (54V)*	-	-	-	3.0 (40V)*	-	-	-	-	-
V-7 12BY7	1.8V (50V)*	2.2	-	-	-	-	34V (46V)*	-	-	-

Figure 6-5. T-102 Transmitter AF, RF Voltage Chart (Sheet 1 of 2)

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Top Cap
V-8 6146	-	-	-	-	34 (46V)*	-	-	-	-	210 (50)
V-9 6146	-	-	-	-	34 (46V)*	-	-	-	-	210 (50)
V-10 12AT7	-	1.4	1.7	-	-	2.4	.17	-	-	-
	WITH VOX SET TO MIN. (PTT OFF)									
V-11 12AT7	.11	.01	-	-	-	5.8	.2	-	-	-
V-12 6AL5	less than .01	5.2	-	-	less than .01	-	less than .01	-	-	-
V-13 6U8A	-	.82	-	-	-	17V	-	-	0	-
V-14 6AH6	8.2	-	-	-	5.5V	-	2.2	-	-	-

MEASURED WITH HEWLETT-PACKARD 410-B

*Voltage output when probe connected.

Figure 6-5. T-102 Transmitter AF, RF Voltage Chart (Sheet 2 of 2)

INSTRUCTION MANUAL
REL TYPE R-104
RECEIVER

May 12, 1960

MANUFACTURED BY
RADIO ENGINEERING LABORATORIES, INC.
29-01 Borden Avenue
LONG ISLAND CITY 1, N. Y.

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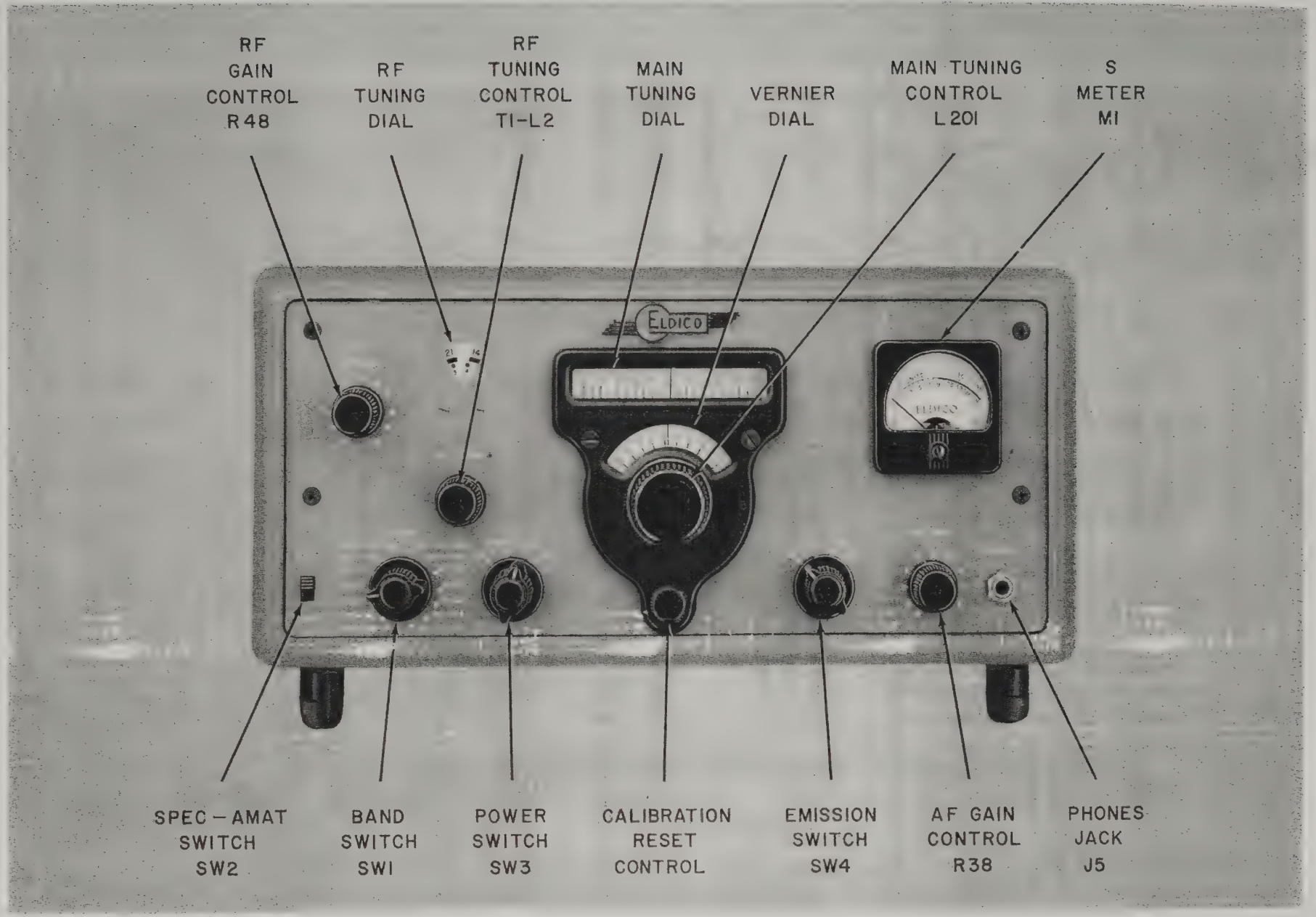


Figure 1-1. R-104 Receiver

SECTION 1

RECEIVER INTRODUCTION

1-1. GENERAL DESCRIPTION. (See figure 1-1). The R-104 Receiver is capable of reception in Single Sideband (upper and lower), CW and AM, between 3.5MC and 30MC. Tuning for the double conversion Receiver is accomplished by low-drift crystal oscillators and an essentially linear variable frequency oscillator (VFO). The Receiver requires 115V AC, 60 CPS but provisions are included to utilize 6, 12, or 24V DC power supplies. The two outputs provided are: a 600 ohm balanced for phone patch operation, and a 4 ohm unbalanced for speaker operation. R-104 Receiver covers the Amateur frequencies with provisions for tuning Special (MARS) frequency bands.

1-2. LIST OF SPECIFICATIONS. Features and specifications of the R-104 Receiver include the following:

Crystals	12 supplied (Amateur) 1 100KC calibration 2 carrier oscil ator
Frequency range	3.5MC to 30MC
Operation modes	USB, LSB, CW and AM
Sensitivity	One microvolt for 10DB signal-to-noise ratio
Selectivity	SSB operation: 2.1KC at 6DB down 4.2KC at 60DB down CW operation: 0.5KC at 6DB down 1.0KC at 60DB down AM operation: 2.1KC at 6DB down 4.2KC at 60DB down
Spurious response	Image rejection better than 50DB down
Frequency stability	After 30 minute warm-up, within 100 CPS
Dial accuracy:	
Electrical	300 CPS on any band
Visual	200 CPS on any band
IF frequency	1st. 2.95MC 2nd. 455KC

Band width	2.1KC on all bands - AM, SSB 500 CPS - CW
Dial backlash	Less than 50 CPS on any band
Output level	0.75 watts
Audio range	300 to 2400 CPS
Input power	115V AC, 60 CPS 90 watts
Size	6-7/8 inches high, 14-7/8 inches wide, 12 inches deep
Weight	20 pounds

NOTE

Two additional 100KC segments of the 10 meter band may be used by installing the proper crystals (not supplied) in the unused 2E and 3E crystal sockets.

1-3. TUBE COMPLEMENT. Tube complement of the R-104 Receiver is as follows:

Two	6DC6	RF amplifier, Crystal cal. osc.
One	6AH6	HF local oscillator
Three	6BE6	First mixer, Second mixer, Product detector
Two	6BA6	First, second IF amplifier
One	6AT6	AM detector, AVC amplifier, First audio
One	6AQ5	Audio output
One	6U8A	VFO osc., VFO cathode follower

1-4. FUSE COMPLEMENT. The R-104 Receiver has one fuse, electrically in series with the power transformer primary. It is:

One	1 Amp. 250V 3AG (SLOW BLOW)

1-5. SEMI-CONDUCTOR COMPLEMENT. The semi-conductor complement of the R-104 Receiver is as follows:

Five	Silicon diodes comprising rectifiers CR1, CR2, CR3, CR4, CR5.
One	Crystal Diode 1N34A CR201

1-6. QUARTZ CRYSTAL COMPLEMENT. The R-104 Receiver is equipped with 15 quartz crystals. Eleven of these crystals cover the Amateur frequency bands, two are SSB carrier crystals, one is a calibration crystal and one is used to tune WWV for Receiver calibration. The comp ete list including the frequency of each crystal follows:

R.F. Crystals

Quantity	Frequency
One	6.455MC
One	6.655MC
One	6.855MC
One	10.055MC
One	10.255MC
One	12.0275MC
One	12.1275MC
One	12.2275MC
One	15.7775MC
One	17.055MC
One	17.255MC
One	17.855MC -(WWV tuning)

SSB Carrier Frequency Control

Quantity	Frequency
One	453.8KC (LSB)
One	456.4KC (USB)

Calibration Frequency Control

One	100KC

SECTION 2

RECEIVER INSTALLATION

2-1. UNPACKING. Unpack carefully to avoid damaging equipment. Examine carefully for visible damage. Check that all tubes are properly seated in sockets. Check action of all controls and switches. If equipment is found to have sustained any damage in shipment or if its condition on arrival is in any way less than perfect, save container and packing materials and notify transportation company.

2-2. AMATEUR CRYSTAL SELECTION. With the SPEC-AMAT switch SW2 in the AMAT position, the Receiver is set to receive in the Amateur bands, and for this purpose 11 Amateur frequency crystals are supplied. The Amateur crystal board is marked with the frequency of the crystals to be inserted, except sockets marked 3C (not used) and sockets 2E and 3E.

NOTE

Only one 10 meter Amateur crystal is supplied. If broader coverage is desired insert Amateur frequency crystals in sockets 2E and 3E.

BAND Switch Positions	Band Range	Crystal Supplied
80 meter band		
1A	3.4 to 3.6MC	6.455MC
2A	3.6 to 3.8MC	6.655MC
3A	3.8 to 4.0MC	6.855MC
40 meter band		
1B	7.0 to 7.2MC	10.055MC
2B	7.2 to 7.4MC	10.255MC
20 meter band		
1C	14.0 to 14.2MC	17.055MC
2C	14.2 to 14.4MC	17.255MC
3C	14.8 to 15.0MC (WWV reception)	17.855MC

BAND Switch Positions	Band Range	Crystal Supplied
15 meter band		
1D	21.0 to 21.2MC	12.0275MC
2D	21.2 to 21.4MC	12.1275MC
3D	21.4 to 21.6MC	12.2275MC
10 meter band		
1E	28.5 to 28.7MC	15.7775MC
2E	As Selected	Not supplied
3E	As Selected	Not supplied

2-3. SPECIAL CRYSTAL SELECTION. The Receiver is equipped with two crystal boards. The left hand board is for Amateur frequency operation and the right hand crystal board has provisions for installing crystals for operation outside the Amateur bands, which are called Special (MARS) bands. The Special crystal board sockets are marked to correspond to the inner markings of the BAND switch in each unit. The following table compares the Special band range with the Amateur band range.

BAND Switch Positions	Special Band Range	Amateur Band Range
80 meter band Band A	3.5MC to 5.5MC	3.5MC to 4.0MC
40 meter band Band B	6.5MC to 9.0MC	7.0MC to 7.3MC
20 meter band Band C	9.0MC to 15.0MC	14.0MC to 14.35MC
15 meter band Band D	15.0MC to 22.0MC	21.0MC to 21.45MC
10 meter band Band E	22.0MC to 30.0MC	28.0MC to 29.7MC

It therefore should be noted that when operating in Special (MARS) mode with the proper crystal, considerable greater band range is available than in Amateur operation. If it is desired to insert a Special (MARS) crystal, place it in a crystal socket of the right hand board which is marked to correspond to the BAND switch setting, as indicated in the following table.

Right Hand Crystal Socket Board Position	Special Band Range	Special Crystal Frequency Range
1A, 2A, 3A	3.5MC to 5.5MC	6.555MC to 8.555MC
1B, 2B	6.5MC to 9.0MC	9.555MC to 12.055MC
1C, 2C, 3C	9.0MC to 15.0MC	12.055MC to 18.055MC

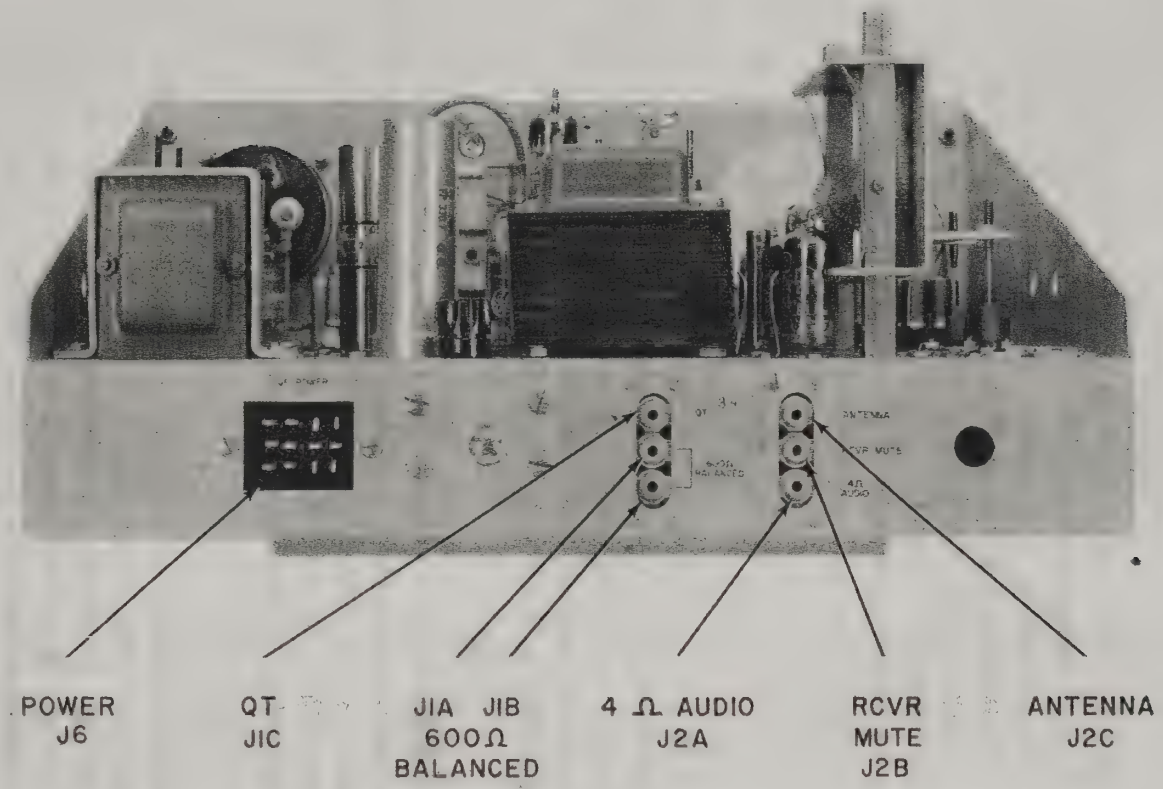


Figure 2-1. R-104 Receiver - External Connections

Right Hand Crystal Socket Board Position	Special Band Range	Special Crystal Frequency Range
1D, 2D, 3D	15.0MC to 22.0MC	9.0275MC to 12.5275MC
1E, 2E, 3E	22.0MC to 30.0MC	12.5275MC to 16.5275MC

NOTE

The crystal sockets of the Special (MARS) crystal socket board have the same markings as the BAND switch. For example: if a Special (MARS) crystal is inserted in crystal socket 2C, then the BAND switch must be placed on 2C. The Receiver will not function if the BAND switch is placed to an empty socket position.

2-4. CRYSTAL SELECTION FORMULA.

2-5. LOW FREQUENCY. To receive on any frequency below 15MC determine crystal frequency by adding the first IF band pass frequency to the lower edge of the operating frequency band desired. For example, if the desired frequency is within band 1B (7.0 to 7.2MC), add the first IF band pass frequency, 3.055MC to the lower edge (7.0MC) and obtain the result of 10 055MC which is the frequency of the crystal to be selected.

2-6. HIGH FREQUENCY. For operating frequencies above 15MC follow the same method as outlined in paragraph 2-5, and divide the result by 2; for example, a frequency is desired in the 21.0MC to 21.2MC band (BAND switch SW1 setting 1D). Then 21.0MC added to 3.055MC and divided by 2 equals 12.0275MC. The 12.0275MC is the frequency of the selected crystal.

2-7. POWER CONNECTORS. The Receiver normally operates from a 115V AC, 60 CPS, single phase power source. However provisions are available to connect the Receiver to 6V, 12V, or 24V DC power source, although this requires an additional source of plate and bias voltage. When using 24V DC power source, connect the required resistors as indicated on the Receiver schematic. A cable is supplied for 115V AC external power use and terminates in POWER jack J6 of the Receiver. To operate from power sources other than 115V AC, disassemble and rewire the POWER jack as follows:

POWER jack J6 Pin Number	6V DC	12V DC	24V DC
1	Filament ground	Filament ground	Filament ground
2	Filament ground	Filament ground	24V filament

POWER jack J6 Pin Number	6V DC	12V DC	24V DC
3	Filament ground	12V filament	Not used
4	6V filament	To terminal 6	Resistor
5	Not used	Not used	Not used
6	6V filament	To terminal 4	Not used
7	+250V DC	+250V DC	+250V DC
8	Ground	Ground	Ground
9	-50V bias	-50V bias	-50V bias
10	Not used	Not used	Not used
11	Power supply switch	Power supply switch	Power supply switch
12	Power supply switch	Power supply switch	Power supply switch

2-8. RECEIVER CONNECTION-SYSTEM OPERATION. External connections to the Receiver are made to the chassis, rear apron and front panels, and are listed in table 2-1. See figure 2-1.

2-9. RECEIVER CONNECTION-SEPARATE OPERATION. Table 2-1 lists connections required to be made to the Receiver, should the Receiver be used alone. If using the Receiver separately, see figure 2-1 and proceed as follows:

CAUTION

Provide adequate space for cable connections and proper air circulation. Tube life is shortened considerable if adequate ventilation is not provided.

a. Connect antenna to the ANTENNA jack J2C.

b. If a speaker is to be used, connect the two leads of the speaker to the 4Ω AUDIO jack J2A.

c. If headphones are to be used, connect the headphones to PHONES jack J5.

NOTE

Headphones inserted into PHONES jack J5 will cut off the loud speaker.

d. Using the power cord with the 12 pin connector, plug the 12 pin connector into the POWER jack J6 of the Receiver. Plug in the other end of the power cord into a 115V AC, 60 CPS, single phase, power outlet.

TABLE 2-1. RECEIVER EXTERNAL CONNECTIONS

Ref. No.	Nomenclature	Receiver Alone	System Connection
J1A	600Ω BALANCED	Not used	TB1-5 RCVR and TB2-7 SPKR (Control Unit)
J1B	600Ω BALANCED	Not used	TB1-4 RCVR and TB2-6 GRD (Control Unit)
J1C	QT	Not used	J3B QT (Transmitter)
J2A	4Ω AUDIO	Speaker connections	TB2-7, 8 SPKR (Control Unit)
J2B	RCVR MUTE	Not used	J7B MUTE (Transmitter)
J2C	ANTENNA	Antenna input	J1C RCVR (Transmitter)
J3	XTAL OSC OUTPUT	Plug in P3	J6 XTAL OSC. INPUT (Transmitter)
J4	VFO OUTPUT	Not used	J5 RCVR VFO INPUT (Transmitter)
J5	PHONES jack	Headphone connection	Headphone connection
J6	POWER	115V AC power outlet	J3 RCVR (Control Unit)

SECTION 3

RECEIVER OPERATION

3-1. OPERATING CONTROLS. The operating controls of the Receiver are located on the front panel. The function of these controls is as follows:

Reference No.	Control	Function
R48	RF GAIN control	Sets the amount of negative voltage applied to the control grids of the RF and IF tubes.
T1-L2	RF TUNING control	Tunes Receiver input.
	RF TUNING dial	Indicates receiving frequency.
SW1	BAND switch	Selects frequency band required between 3.5MC and 30MC.
SW2	SPEC-AMAT switch	
	SPEC position	Selects crystal board necessary for Special frequency operation.
	AMAT position	Selects crystal board necessary for Amateur frequency operation.
SW3	Power switch	
	OFF position	Receiver power off.
	STBY position	Receiver in ready condition.
	OPR position	Receiver in operating condition.
	CAL position	Insert 100KC calibration frequency into Receiver.
L201	Main tuning control	Tunes VFO over 200KC range to supply oscillator frequency to second converter. Moves hair line over main tuning dial.

Reference No.	Control	Function
	Main tuning dial	Provides a reading of Receiver frequency in 10KC increments.
	Vernier dial	Provides a reading of Receiver frequency in 1KC increments.
	Calibration reset control	Controls hair line setting for vernier dial.
SW4	Emission switch	Changes mode of reception.
	AM position	Readies Receiver for AM reception.
	LSB position	Connects LSB oscillator to detector circuit for LSB carrier re-insertion.
	USB position	Connects USB oscillator to detector circuit for USB carrier re-insertion.
	CW position	Readies Receiver for CW reception by establishing a signal path through 0.5KC bandwidth filter FL2.
M1	S meter	Indicates signal strength of incoming signal when RF gain is at maximum.
R38	AF GAIN control	Adjusts degree of loudness in the audio output.
J5	PHONES jack	Output for connecting headphones.
I1, I2	Dial lamps	Illuminates tuning dials.

3-2. RECEIVER OPERATION. The Receiver is designed to operate from a 115V AC, 60 CPS, single phase power source, and an antenna impedance of 50 ohms resistive. The operating instructions are based on these requirements, the assumption that the installation has been properly completed, and that the equipment is in good working order. This equipment has been factory tested and accepted. To operate the Receiver proceed as follows:

NOTE

The operating frequency of the Receiver is equal to the BAND switch setting plus the main tuning dial setting, for example: If the BAND switch is on 7.0MC and the dial reads 99, then the operating frequency of the system is 7.099MC (7099KC).

a. Energize Receiver by placing RCVR switch (Control Unit) to ON, and allow 20 minutes for proper warm-up.

b. Place power switch (Receiver) to OPR.

c. Place emission switch to desired mode of reception; for example, LSB.

d. Place SPEC-AMAT switch to desired position; for example, AMAT.

e. Set BAND switch to desired frequency band; for example 1C-14.0 position.

NOTE

Be certain that the crystal is installed in the crystal socket. For example, if the BAND switch is placed in 1C-14.0 position, check that the proper crystal is installed in the crystal socket.

f. Adjust RF TUNING control until RF TUNING dial indicates proper band number to correspond to the BAND switch. For Special operation refer to figure 3-1 for numbers to use in tuning.

g. Turn RF GAIN control maximum clockwise.

h. Place AF GAIN control at mid-range.

i. Tune in desired signal by turning main tuning control, slowly.

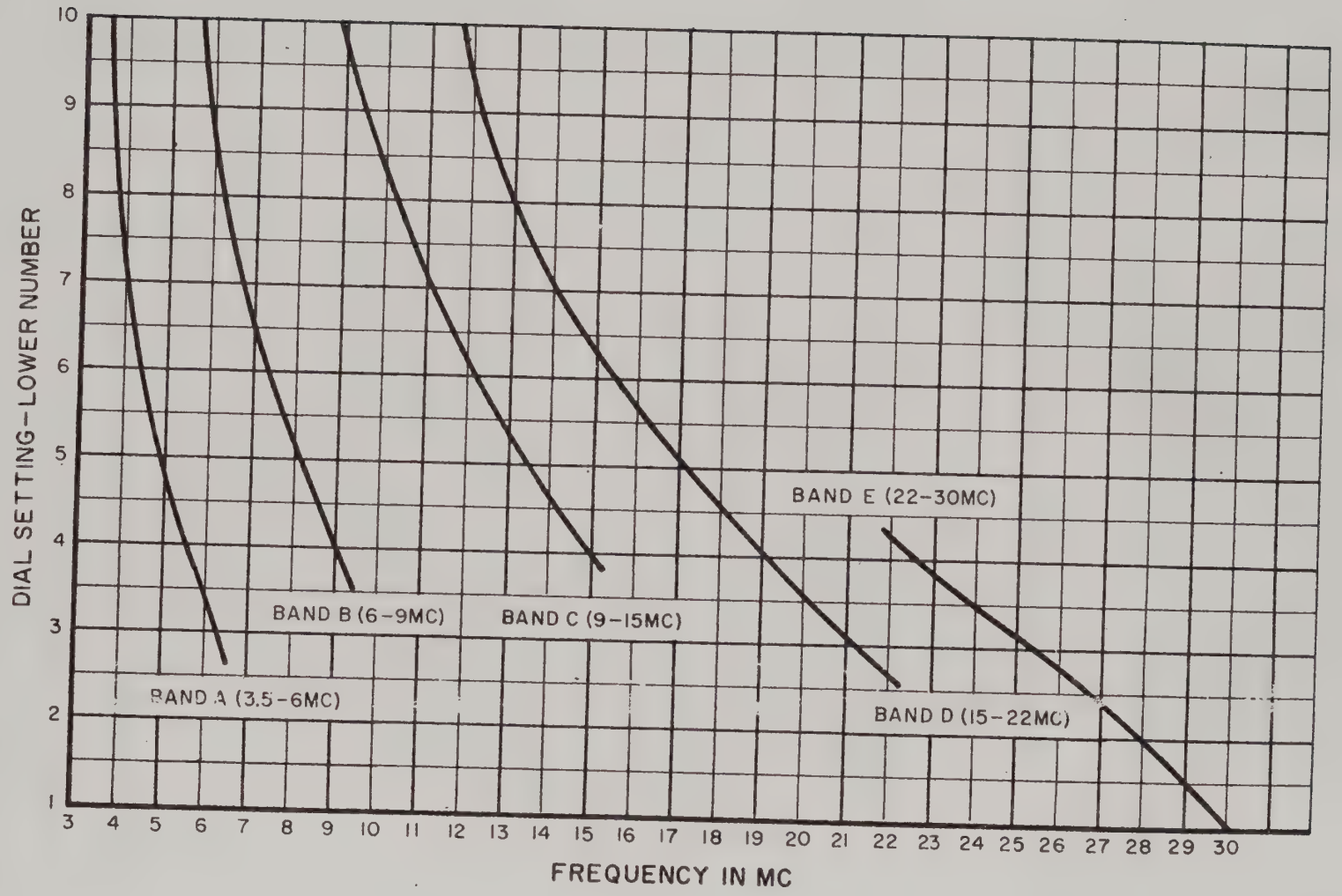


Figure 3-1. RF Tuning Dial Setting - Special

NOTE

When tuning for CW signals with filter FL2 installed it is essential that the main tuning control be rotated slowly due to the narrow bandwidth of the I.F. filter. If filter FL2 is not included in the Receiver the CW position is inoperative. In this case, use LSB or USB positions of emission switch for CW reception.

j. Readjust the RF TUNING control for maximum signal output.

NOTE

The loudspeaker is located in the Control Unit. Headphones inserted in PHONES jack will cut off the loudspeaker.

k. Adjust RF GAIN and AF GAIN controls for volume.

l. Observe S meter (Receiver) for indicated received signal strength.

NOTE

If operating in Special (MARS) be certain that the BAND switch is on the same setting as the markings on the Special crystal socket board, that is: A MARS frequency crystal is installed in 1C, then BAND switch must be at 1C to receive in the 9.0-15.0MC range.

m. Calibrate the Receiver as follows:

1. Place the power switch to CAL position.

2. Place AF GAIN control to mid-range position.

3. Place RF GAIN control to maximum clockwise position.

4. Rotate main tuning control until the main tuning dial indicates 100 at which time an audio tone is heard. Slowly rotate main tuning control until the audio tone diminishes in frequency to an inaudible level (zero beat). Adjust the calibration reset control until the hair line on the vernier dial indicates 0.

n. Reset power switch to OPR position.

o. Check that the controls are in the position indicated in table 3-1.

The positions listed are for upper sideband mode of operation (USB) and a frequency of 14.085 MC.

TABLE 3-1. RECEIVER OPERATION

Control	Position
RF GAIN control	Mid-range
RF TUNING control	*RF TUNING dial indicates 14
BAND switch	*1C-14.0
SPEC-AMAT switch	AMAT
Power switch	STBY
Main tuning control	*Main tuning dial indicates 80 and Vernier dial indicates 5
Emission switch	USB
AF GAIN control	Mid-range

*Position of control varies with frequency desired to receive.

SECTION 4

RECEIVER THEORY OF OPERATION

4-1. GENERAL. (See figures 4-1 and 4-2.) The Receiver is a completely contained unit and may be operated as a separate Receiver. The Receiver is a double conversion, superheterodyne type, consisting of an RF amplifier first mixer, high frequency crystal oscillator and a VFO tuned by the main tuning dial to provide the second conversion stage with a local oscillator frequency. The second intermediate frequency (455KC) is supplied to two stages of IF, followed by a detector and two stages of audio amplification. Termination may be into a speaker voice coil (or headphones), a telephone line, or both. Separate detectors are used for AM and SSB/CW detection. A Receiver calibration stage for calibrating the Receiver main tuning dial and vernier dial, and two narrow mechanical filters providing a high degree of selectivity are features of this Receiver. The Receiver is powered by a full wave rectifier operating from the conventional 115V AC line through a power transformer.

4-2. RF CIRCUITS. The RF circuits consist of an antenna input jack J2C, tuning components and RF amplifier V1. The incoming signal is applied to the shunt RF tuning components for pre-selection and then to the input of V1. The desired band is tuned by the RF TUNING control which varies the inductance of two coils T1 and L2. Coil T1 is shunted by padder and trimmer capacitors, C1 through C8, and selected by BAND switch SW1. The output of V1 is fed to the first mixer tube V3, where the second tuning coil L2 is shunted by padder and trimmer capacitors, C18 through C25, and selected by BAND switch SW1. The S meter M1 is connected across a portion of the plate load resistor R8 of tube V1 and indicates the received signal strength. The S METER ADJUST resistor R9, selects a portion of the plate current to be passed through the meter (Receiver). The amount of signal allowed to pass is controlled by RF GAIN R48, and RF GAIN ADJUST R49. These resistors establish the operating level for the RF and IF tubes. Bias voltage is obtained from the Power Supply (paragraph 4-13). The output of V1 is fed to V3 the first mixer tube to become the first intermediate frequency.

4-3. FIRST MIXER CIRCUIT. The first mixer circuit consists of V3, two slug tuned IF transformers T2 and L1, and associated circuitry. The received signal is applied to one input of V3 and a high frequency crystal oscillator frequency is applied to another input (paragraph 4-10). For any received frequency selected in the RF circuits the proper crystal is applied to the second input to produce in the output of V3 a band of frequencies from 2.855MC to 3.055MC. These frequencies are applied to the IF transformer T2, which in addition to L1 is tuned to pass 200KC (2.855MC to 3.055MC) and becomes an input of the second mixer.

4-4. SECOND MIXER CIRCUIT. The second mixer circuit consists of V4, mechanical filters FL1 and FL2, emission switch SW4 and a variable frequency input. The 2.855MC to 3.055MC frequencies from the first mixer circuit are

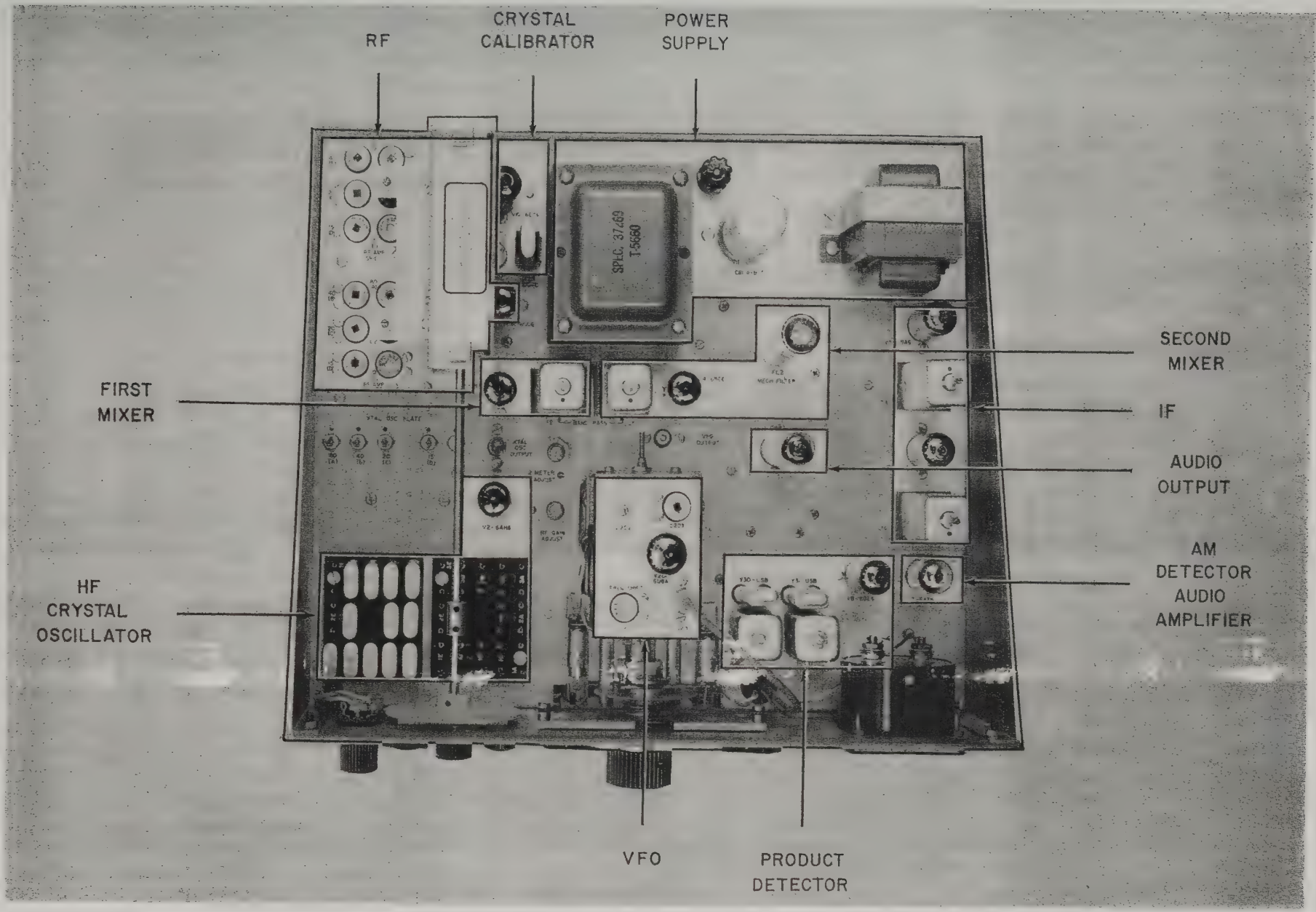


Figure 4-1. R-104 Receiver - Section Location

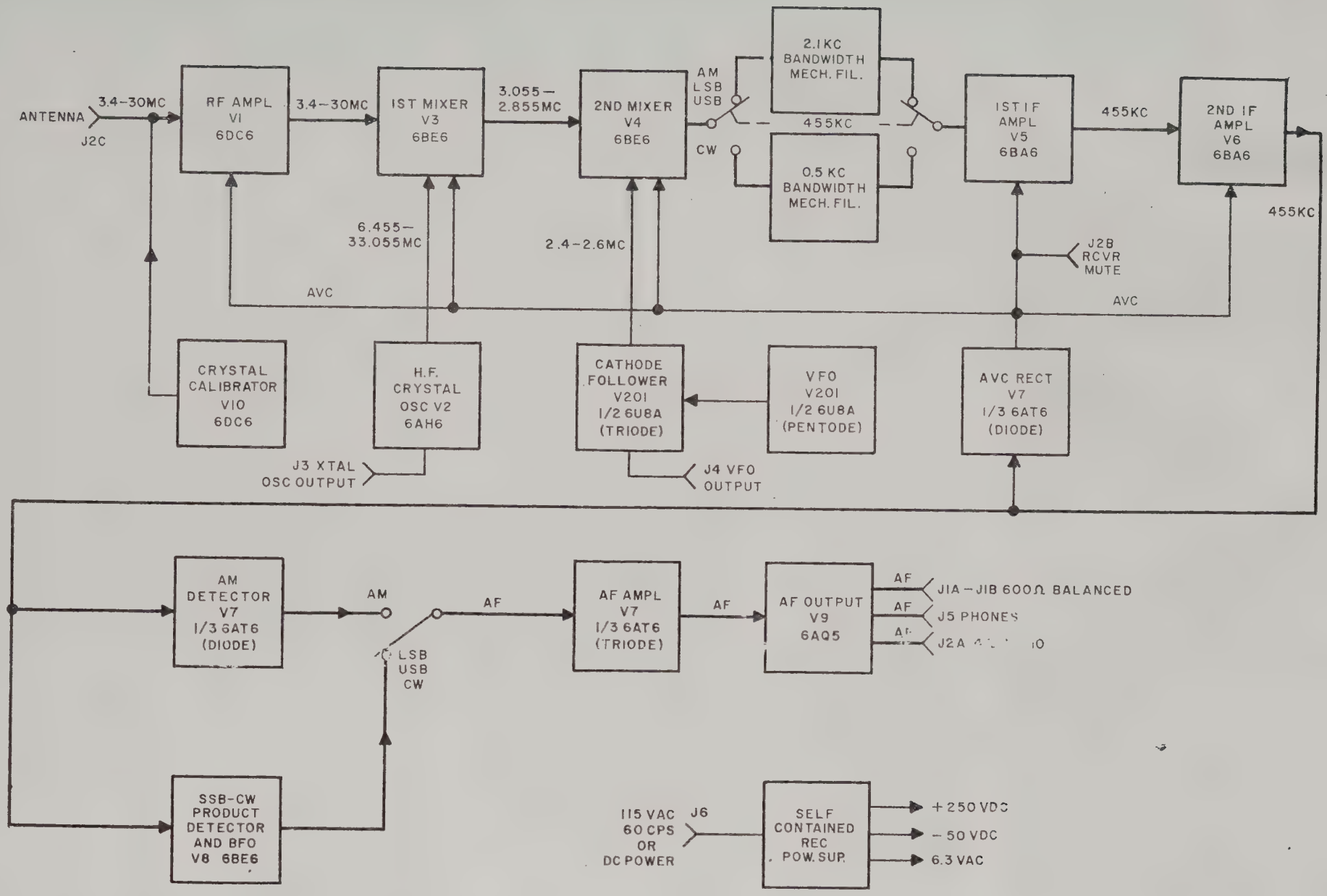


Figure 4-2. R-104 Receiver Block Diagram

applied to an input of V4 and a second frequency of 2.4MC to 2.6MC from the variable frequency oscillator is passed to a second input of V4 (paragraph 4-11). These frequencies are combined in V4 to produce an intermediate frequency of 455KC which is passed to mechanical filter FL1, providing emission switch SW4 is in AM, LSB or USB positions. The mechanical filter allows frequencies from 456.05KC to 453.95KC, or 2.1KC to pass, attenuating all others sharply. If emission switch SW4 is in CW position and the Receiver is equipped with filter FL2, the bandpass is reduced to 455.25KC and 454.75KC, or 0.5KC. From emission switch SW4 these signals are passed to the input of V5, the first IF amplifier tube.

4-5. IF CIRCUITS. The first and second IF amplifiers consist of the first IF amplifier tube V5, IF transformer T3, second IF amplifier tube V6, IF transformer T4 and associated circuitry. The second IF signal is passed to V5 where it is amplified and passed to IF transformer T3. This slug tuned transformer peaks the signal and passes it to the second IF amplifier tube V6 where it is again amplified and applied to the second slug tuned IF transformer T4 to further peak and pass the signal to the detector.

4-6. DETECTOR CIRCUITS. The detector circuits consist of AM detector V7, product detector V8, and crystal oscillators Y30 and Y31. If the emission switch SW4 is placed in AM position the product detector is removed from the circuit and the 455KC signal is detected in the usual manner by the diode portion of V7 then passed to the audio circuits via AF GAIN control R38. If the emission switch SW4 is in any other position, then detection is accomplished in the product detector V8. The second IF signal is applied to an input of V8, and a crystal oscillator signal of either 453.9KC (LSB) or 456.4KC (USB) is applied to the input of V8, through emission switch SW4. The output of V8 is filtered and a signal varying at an audio rate is applied to the first audio amplifier, the triode section of V7.

4-7. AUDIO OUTPUT CIRCUIT. The audio output circuit consists of the first audio, the triode portion of V7, the audio output tube V9 and the audio output transformer T5. AM audio, detected in V7, is passed to the AF GAIN control R38 which determines the amount of audio signal applied to the GRID of V7. SSB or CW audio detected in the product detector V8 is applied to the same input of V7. The audio response is practically flat from 300 to 2400 CPS. The two secondaries of T5 have output impedances of 4Ω and 600Ω. The 4Ω secondary is terminated in a speaker coil and the 600Ω balanced output secondary is terminated in a telephone line (if required). Headphones, which cut out the loudspeaker, may be used.

4-8. OSCILLATOR CIRCUITS. The Receiver contains four oscillator circuits, as follows: The crystal calibrator oscillator V10, the high frequency crystal oscillator V2, the VFO oscillator V201, and the carrier reinsertion oscillator V8.

4-9. CRYSTAL CALIBRATOR OSCILLATOR. The crystal calibrator oscillator consists of a 100KC crystal oscillator, the oscillator tube V10, and associated circuitry. The output of the crystal calibrator circuit is connected into the RF section through the power switch SW3 and the input coil of T1, producing a fixed frequency

of 100KC with harmonics at 100KC increments to calibrate the tuning dial of the Receiver. Capacitor C11 adjusts the input frequency over a narrow range to compensate for any unavoidable drift of the 100KC crystal.

4-10. HIGH FREQUENCY CRYSTAL OSCILLATOR. The high frequency crystal oscillator consists of provisions for 28 crystals mounted on two selector boards. One board contains crystals for tuning in the Amateur receiving bands Y1 and Y14 and the other board contains crystal sockets for Special (MARS) band tuning (Y15 to Y28). The selector boards are chosen by SPEC-AMAT switch SW2, and the crystals are selected by BAND switch SW1. The desired crystal frequency is passed to the input of V2. The output of V2 is tuned by pre-tuned coils L5 through L9 selected by Band switch SW1, and coupled to the first mixer tube V3, refer to paragraph 4-3. The five input positions of BAND switch SW1 (wafer A and B) in the RF amplifie correspond to the five tuned positions of the high frequency Band switch SW1 (wafer E) of the crystal oscillator output circuit.

NOTE

The output of the high frequency crystal oscillator V2 is equal to the frequency of the crystals when the bands selected are below 15MC. Above 15MC the high frequency crystal oscillator V2 is tuned by coils L8 and L9 to oscillate at the second harmonic or twice the crystal frequency. The oscillator output for any frequency is 3.055MC higher than the lower edge of the desired band, and 2.855MC higher than the upper edge of the band.

An output jack J3 XTAL OSC OUTPUT located on the Receiver chassis is provided for system operation. When not in use, this jack should contain a special shorting plug P3, placing the RF output to ground.

4-11. VARIABLE FREQUENCY OSCILLATOR (VFO). The VFO oscillator is a sub-chassis of the main Receiver chassis and provides mixing frequencies to the cathode input of the second mixer tube V4. The oscillator consists of V201, cathode coupled to the input of the second mixer tube V4, (paragraph 4-4). Stability and accurate frequencies of the VFO are obtained by the use of a modified colpitts oscillator equipped with temperature compensating capacitors. The pentode section of V201 functions as the oscillator amplifier. The triode section couples the output signal in a cathode follower circuit through a short coaxial cable. The main tuning dial varies the slug in a coil to provide a tuning range of 2.4 to 2.6MC. A small variable capacitor C211 and a crystal diode CR201 are connected across the tuned circuit RFC 201 and C210 in the cathode of the pentode section of V201. A lead is brought to the emission switch SW4 through a dropping resistor R209. With the emission switch SW4 on either CW or USB, positive voltage is applied through R209

to the frequency switching diode CR201. This voltage causes the diode CR201 to conduct and C211 is connected to ground in parallel with the tuned circuit RFC201 and C210 providing additional capacity to the oscillator circuit and thus decreasing the frequency. When the emission switch SW4 is placed in either LSB or AM, negative voltage is applied to CR201 opening the circuit to ground and C211 is left floating increasing the oscillator frequency. The amount of frequency change is sufficient to permit the change from USB to LSB without retuning the Receiver.

CAUTION

Do not open the VFO oscillator can unless part replacement is necessary. The VFO is factory set and requires careful handling.

4-12. POWER SUPPLY. The power supply to the Receiver consists of a 12 pin connector input POWER jack J6, a one ampere slow blow fuse F1, a power transformer T6 with two secondary windings, five silicon rectifiers CR1 to CR5 and an output filter R46, L12, C81A and C81B. When the Receiver power cord from POWER jack J6 is connected to 115V AC and the power switch SW3 (Receiver) is moved from the OFF position, current flows through power switch SW3 (Receiver) from one side of the power line, through the one ampere slow blow fuse into the primary of T6. The secondary of T6 is composed of a high voltage winding for the plate and screen supply, and a low voltage winding for the filament supply. Bias voltage is obtained through a tap on the secondary. Four silicon rectifiers, CR1, CR2, CR3 and CR4 are connected in series to each end of the secondary to provide full wave rectification. Another silicon rectifier CR5 is connected to a tap on the high voltage secondary to provide a negative bias voltage to control the RF and IF tubes with the VOX circuits in the Transmitter. The rectified DC is applied to a pi type filter which produces a DC voltage with very low AC ripple content. The low voltage secondary which supplied the filaments also lights the two dial lamps. The 12 connector POWER jack J6 is so arranged that the filaments and dial lamps will function on 6, 12, or 24V DC.

4-13. AVC. The AVC voltage developed across R33 is applied to the grids of V1, V3, V4, V5, and V6. The RF GAIN control R48 provides manual gain control of the Receiver and RF GAIN ADJUST R49 determines the level at which the AVC is applied to the tubes, and is present in all modes of reception. When the power switch SW3 is placed on STBY, ground is established through R50 for the negative voltage supply which raises the bias level applied to the RF and IF tubes to a point where they are completely cut-off.

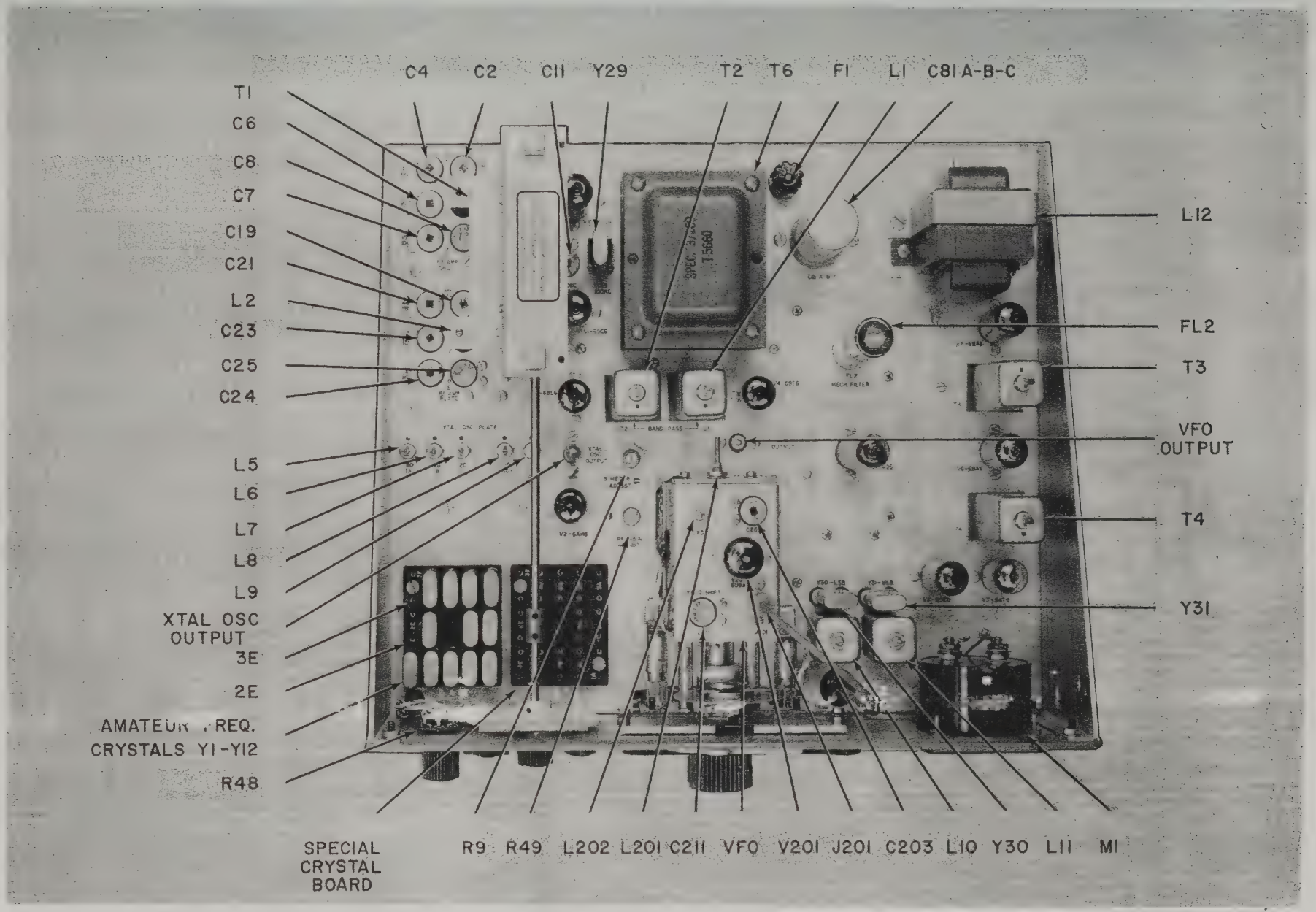


Figure 5-1. R-104 Receiver - Top View

SECTION 5

RECEIVER MAINTENANCE

5-1. GENERAL. The Receiver is aligned before shipment and accepted for proper operation. Should circumstance require realignment and maintenance, remove two screws at the sides of the case and lift the lid. This provides access to the top of the chassis. To remove the chassis from its case, loosen the screws holding the rubber feet and lift the chassis clear. See figures 5-1 and 5-2.

5-2. EQUIPMENT REQUIRED. Equipment, or equivalent, required for alignment of the Receiver is as follows:

a. Multimeter, 20,000 ohms per volt, Simpson 260.

b. Signal generator, Hewlett-Packard 606A.

c. VTVM with RF probe, Hewlett-Packard 410B.

5-3. PRELIMINARY ALIGNMENT. Determine that all tubes are properly seated in their sockets and carry out the following preliminary procedures to check the audio stages.

a. Connect a 4-ohm speaker to the 4Ω AUDIO jack J2A, or plug a headset into PHONES jack J5.

b. Connect the power cord to a 115V AC, 60 CPS, single phase power supply, and allow sufficient warm-up time before making adjustments.

c. Place power switch SW3 to OPR. (See figure 1-1)

d. Set VTVM to ⨍300 volt scale.

e. Connect VTVM from the chassis to junction of L12 and C81B. Meter should read ⨍250V ±10 volts. (See figure 5-2)

f. Observe that the dial lamps and all tube filaments are lit.

g. Set emission switch SW4 to AM.

h. Connect the signal generator, set at 455KC with 30% modulation at 400 cycles, to pin 5 of V7. Tone should be audible in the loudspeaker.

i. Adjust AF GAIN control R38 for sound volume.

j. Set VTVM to a low volts scale and connect it to the junction of R33 and the arm of variable resistor R48 RF GAIN control. (See figure 5-1 and figure 5-2.)

k. Adjust RF GAIN ADJUST R49 on chassis until VTVM reads -1.5V. (See figure 5-1.)

5-4. IF ALIGNMENT. (See figure 1-1.) To perform the IF alignment set the Receiver controls as follows:

Reference No.	Control	Position
SW3	Power switch	OPR
SW1	BAND switch	Empty crystal socket position
SW4	Emission switch	AM
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise

Proceed with the following steps:

a. Remove cable from VFO jack J201.

b. Connect shorting jumper across R33. (See figure 5-2)

c. Connect VTVM, set to 10 volt AC scale, across 600 Ω resistor which is placed across 600Ω BALANCED jacks J1A and J1B, on rear of the chassis.

d. Connect signal generator, set at 455KC with 30% modulation at 400 cycles, to pin 7 of V4.

e. Turn top and bottom slugs of T3 and T4 completely counter clockwise. (See figure 5-1 and figure 5-2.)

f. Adjust bottom slugs of T3 and T4 for maximum reading on VTVM.

g. Repeat step f except for top slugs of T3 and T4.

NOTE

As the VTVM reading rises, reduce the signal generator output.

h. Vary signal generator output frequency about 2KC each side of 455KC to locate the exact center of the mechanical filter FL1. Choose the highest reading on the VTVM.

i. Repeat steps f and g for maximum VTVM reading.

NOTE

Sensitivity of the IF circuit should read 5 volts output on the VTVM for 20 to 25 microvolts input from the signal generator.

j. Remove VTVM and signal generator. Replace VFO cable to J201 and remove the shorting jumper across R33.

5-5. CARRIER REINSERTION CRYSTAL ADJUSTMENT. (See figure 1-1.) To perform carrier reinsertion crystal adjustment positi n the Receiver controls as follows:

Reference No.	Control	Position
SW3	Power switch	OPR
SW1	BAND switch	Position to empty crystal socket
SW4	Emission switch	LSB
R48	RF GAIN control	Fully clockwise
R38	AF GAIN control	Fully clockwise

Proceed with the following:

a. Remove the cable from VFO jack J201.

b. Connect a 4-ohm loudspeaker into the 4 Ω AUDIO jack J2A.

c. Connect a shorting jumper across R33.

d. Connect the signal generator, set at 455KC with no modulation, to pin 7 of V4.

e. Connect VTVM with RF probe to pin 1 of V6. Set scale to one volt.

f. Tune signal generator slowly from 453 to 457KC, and observe VTVM.

NOTE

It is essential that the signal generator be tuned slowly and to observe the VTVM closely. Four peak readings will be observed. Choose the highest peak and adjust the signal generator voltage output for a one volt reading on the VTVM.

g. Decrease frequency output of the signal generator until the VTVM reads 0.10 volt (20DB down).

h. Adjust the slug of L10 until the speaker signal is at zero beat. Adjust C87 and L10 until 15 volts peak to peak or 5.3 volts RMS is measured at pin 2 of tube V8, while maintaining a zero beat at the loudspeaker. (See figure 5-1 and figure 5-2.)

i. Set emission switch SW4 to USB.

j. Increase the signal generator frequency until the VTVM reading rises through one volt and falls to 0.10 volt (20DB down).

k. Repeat step h except tune slug of L11 and adjust C88.

l. Set power switch SW3 to OFF and remove the signal generator, VTVM, and the shorting jumper on R33. Replace VFO cable to J201.

5-6. BANDPASS IF ALIGNMENT. (See figure 1-1.) To perform the band pass alignment proceed with the controls set as follows:

Reference No.	Control	Position
SW3	Power switch	OPR
SW1	BAND switch	Unused crystal socket
SW4	Emission switch	AM
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise

a. Remove cable from VFO jack J201.

b. Connect shorting jumper across R33.

c. With VTVM set on 1.5 volt scale connect RF probe to junction of C48 and C49. (See figure 5-2.)

d. Turn the top and bottom slugs of T2 and L1 all the way in. (See figure 5-1 and figure 5-2.)

e. Set the signal generator at 2955KC unmodulated, and connect it to pin 7 of V3. Adjust output voltage to 0.2 volts.

f. Adjust the three slugs of T2 and L1 for maximum indication on the VTVM.

g. Tune the signal generator to 2890KC and adjust top slug of T2 for maximum VTVM indication.

h. Tune the signal generator to 3035KC and adjust bottom slug of T2 for maximum VTVM indication.

i. Repeat steps g and h until further adjustment of either top or bottom slug does not increase the VTVM reading.

NOTE

Voltage gain for steps c through i, not more than 3.

j. Tune the signal generator to 2955KC and set 400 cycle modulation to 30% with 8 microvolts output.

k. Shift VTVM to 600Ω BALANCED output jacks J1A and J1B on the rear of the Receiver chassis.

l. Adjust the slug of L1 for maximum reading on the VTVM. (With 8 microvolts input the VTVM should read 5 volts).

m. Repeat steps h, i, and k and observe VTVM; there should be little change in the peak reading.

NOTE

If possible the bandpass should be observed on an oscilloscope with a sweep generator to sweep between 2855KC and 3055KC. Under these conditions the oscilloscope pattern should be within 3DB down over the passband range. The skirts should drop sharply at both extremities.

n. Disconnect the signal generator, the VTVM and remove the shorting jumper across R33. Reconnect the VFO cable into J201.

5-7. HIGH FREQUENCY CRYSTAL ADJUSTMENT. (See figure 1-1.) To adjust the high frequency crystals, set the controls as follows:

Reference No.	Control	Position
SW2	SPEC-AMAT switch	AMAT
SW3	Power switch	OPR
SW4	Emission switch	AM
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise

Proceed with the following:

a. Connect VTVM through RF probe to pin 1 of V3.

b. Set BAND switch SW1 on the following positions and tune the associated coil for maximum VTVM indication. (See figure 1-1.)

BAND Switch Position	Coil
2A	80(A)
2B	40(B)
2C	20(C)
2D	15(D)
1E	10(E)

NOTE

Vary the tuning slug of the coils slowly especially the last three. Make certain the largest peak VTVM reading is obtained in each case.

c. Disconnect the VTVM.

5-8. RF TUNING ALIGNMENT. (See figure 1-1.) To align the RF portion of the Receiver, set the controls to the indicated positions and perform the following:

Reference No.	Control	Position
SW1	BAND switch	As necessary
SW3	Power switch	OPR

Reference No. (Cont)	Control	Position
SW4	Emission switch	AM
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise
T1-L2	RF TUNING control	As necessary
	Main tuning dial	200

a. Rotate RF TUNING control until midway between 7 and 8 of lower scale appears within the center of the triangular window of the RF TUNING dial.

b. Check that the tops of the tuning slugs of T1 and L2 are even with the coil forms which they tune. Adjust the slugs if necessary.

c. Connect the signal generator to the ANTENNA input jack J2C.

d. Connect 600Ω resistor across 600Ω BALANCED output jacks J1A and J1B on rear of Receiver chassis.

e. Connect AC VTVM across the above resistor.

f. Use only enough signal from the signal generator to be able to observe tuning peaks on the VTVM.

g. Final tuning adjustments must be made with the signal generator output as low as possible, 3 microvolts or less.

NOTE

In the following table place the RF TUNING control to the upper edge of the band, (heavy black line) for each band indicated except 28MC. Be certain to change signal generator for each BAND switch SW1 change.

Signal Generator Frequency Output	BAND Switch Settings	RF TUNING Control Settings	Tune Capacitor
3.7MC	2A - 3.6MC	3.5MC	C2 80(A)
7.3MC	2B - 7.2MC	7MC	C4 40(B)
14.3MC	2C - 14.2MC	14MC	C6 20(C)

Signal Generator Frequency Output	BAND Switch Settings	RF TUNING Control Settings	Tune Capacito
21.3MC	2D - 21.2MC	21MC	C7 15(I
28.6MC	1E - 28A MC	28MC (Mid-range)	C8 10(I

5-9. 100KC CALIBRATION OSCILLATOR ALIGNMENT. (See figure 1-1.) To perform the 100KC Calibration Oscillator Alignment, place the controls at the following positions:

Reference No.	Control	Position
SW1	BAND switch	3C - 14.8
SW3	Power switch	OPR
SW4	Emission switch	AM
R48	RF GAIN control	As necessary
R38	AF GAIN control	As necessary
	Main tuning dial	200

a. Connect antenna to ANTENNA input jack J2C.

b. Tune Receiver to (WWV) 15MC.

c. Place the power switch SW3 to CAL.

d. Adjust 100KC ADJUST C11 during period when modulation on WWV is absent, until audible beat note is brought to zero with an increase of signal on each side. (See figure 5-1.)

e. Return power switch SW3 to OPR.

5-10. S METER ADJUSTMENT. (See figure -1.) To perform S Meter Adjustment, set the controls in the indicated position and proceed as follows:

Reference No.	Control	Position
SW3	Power switch	OPR
SW4	Emission switch	AM
SW1	BAND switch	3C - 14.8
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise
T1 - L2	RF TUNING control	14.8MC

a. Remove antenna from Receiver set RF GAIN control R48 at maximum.

b. Set S METER ADJUST R9 on the chassis for zero reading on the S meter M1 (Receiver) (See figure 5-1.)

5-11. OVERALL SENSITIVITY TEST. (See figure 1-1.) To perform the Overall Sensitivity Test of the Receiver, set the controls as follows:

Reference No.	Control	Position
SW3	Power switch	OPR
SW4	Emission switch	USB
SW1	BAND switch	As required
R48	RF GAIN control	Maximum clockwise
R38	AF GAIN control	Maximum clockwise
T1-L2	RF TUNING control	As required

a. Connect VTVM to 600Ω BALANCED jacks J1A and J1B. Connect 600Ω resistor across 600Ω BALANCED output and remove the speaker.

b. Connect signal generator set at 3.7MC.

c. Set BAND switch SW1 at 2A-3.6.

d. Place main tuning control at 100.

e. Energize Receiver and allow sufficient warm-up time.

f. Turn on VTVM and signal generator.

g. Place VTVM to 30 volt scale and signal generator to 1 microvolt output.

h. Adjust RF TUNING control until VTVM reads 21 volts or more. (Sensitivity should be 1 microvolt input for 3/4 watt output.)

i. Continue with step h for the following settings of the BAND switch, 2B-7.2, 3C-14.2, 2D-21.2, E-28.5. Adjust the RF TUNING control T1-L2 as necessary. (See figure 5-1.)

5-12. RECEIVER MUTING TEST. (See figure 1-1.) To determine that the Receiver muting circuits are operating properly proceed as follows:

a. Tune in a signal.

b. Set power switch SW3 to STBY. The signal is cut off.

c. Short the inner connector of the jack RCVR MUTE J2B, to the chassis and the signal should reappear.

d. Remove the short circuit from RCVR MUTE J2B.

e. Return power switch SW3 to OPR.

5-13. PHONE JACK TEST. To determine if the PHONES jack J5 is functioning properly, tune in a signal that is heard in the loudspeaker. Insert a phone plug into PHONES jack J5. The loudspeaker is cut off.

5-14. VARIABLE FREQUENCY OSCILLATOR. (See figure 6-3.) The variable frequency oscillator (VFO) is a linear calibrated oscillator with a range of 2.4MC to 2.6MC. The frequency of the VFO is read on two dials. The main tuning dial is divided into 10KC segments and the vernier dial is divided into 1KC segments. Tuning is linear within 300 cycles at any dial point. The VFO is factory aligned and adjusted; and ordinarily does not require adjustments.

5-15. VFO FREQUENCY SHIFT ADJUSTMENT. (See figure 1-1.) To adjust the VFO frequency shift proceed as follows with controls at the position indicated.

Reference No.	Control	Position
SW3	Power switch	CAL
SW4	Emission switch	LSB
SW1	BAND switch	1A-3.4MC
T1-L2	RF TUNING control	3.4MC
L201	Main tuning control	0

a. Increase AF GAIN control R38 and adjust the main tuning control L201 until the audible note in the speaker is at zero beat.

b. Place emission switch SW4 to USB.

c. Adjust C211 in VFO for audible beat note in speaker.

d. Return power switch SW3 to OPR or STBY.

SECTION 6

RECEIVER REFERENCE MATERIAL

6-1. GENERAL. The voltage and resistance charts, the parts list, and the schematic diagram (figure 6-1) for the R-104 Receiver are provided in this section. Reference material for the M-136 Variable Frequency Oscillator is also included.

6-2. R-104 RECEIVER RESISTANCE MEASUREMENT CHART. (See figure 6-2.) The resistance measurements were taken with a multimeter (20,000 ohms per volt) from the pins of the tube sockets to ground. Receiver front panel controls placed as follows:

CAUTION

Remove all input source power to Receiver.

Reference No.	Control	Position
SW3	Power switch	CAL
R48	RF GAIN control	Fully counter-clockwise
R38	AF GAIN control	Fully counter-clockwise
SW2	SPEC-AMAT switch	AMAT

NOTE

Resistances less than 1 ohm are considered as zero ohms.

6-3. M-136 VFO RESISTANCE MEASUREMENT CHART. (See figure 6-3.) Resistance measurements of the VFO were made with tube V-201 removed from its socket using a multimeter (20,000 ohms per volt.)

CAUTION

Remove all input source power to Receiver.

NOTE

Any resistance measurement within 20% of listed value is considered satisfactory.

6-4. R-104 RECEIVER DC VOLTAGE CHART. (See figure 6-4.) Voltage measurements were made with a multimeter (20,000 ohms per volt.) measurements were conducted with the Receiver operating normally with all tubes in their sockets. Voltage measurements were made from the point indicated to the chassis ground, and with the front panel controls positioned as follows:

Reference No.	Control	Position
SW4	Emission switch	USB
R48	RF GAIN control	Fully clockwise
R38	AF GAIN control	Fully clockwise
SW3	Power switch	CAL
SW2	SPEC-AMAT switch	AMAT

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
V-1 6CD6	5.6MΩ	Grd	Fil.	Fil.	150KΩ	180KΩ	Grd
V-2 6AH6	33KΩ	Grd	Fil.	Fil.	150KΩ	200KΩ	60Ω
V-3 6BE6	22KΩ	Grd	Fil.	Fil.	150KΩ	170KΩ	2.8MΩ
V-4 6BE6	22KΩ	Grd	Fil.	Fil.	150KΩ	170KΩ	2.8MΩ
V-5 6BA6	3.0MΩ	Grd	Fil.	Fil.	150KΩ	190KΩ	Grd
V-6 6BA6	2.8MΩ	Grd	Fil.	Fil.	150KΩ	190KΩ	Grd
V-7 6AT6	0-1MΩ	3900Ω	Fil.	Fil.	510KΩ	2.8MΩ	400KΩ
V-8 6BE6	22KΩ	270Ω (LSB)	Fil.	Fil.	210KΩ	170KΩ	100KΩ
V-9 6AQ5	470KΩ	270Ω	Fil.	Fil.	150KΩ	150KΩ	470KΩ
V-10 6DC6	1.5MΩ	Grd	Fil.	Fil.	300KΩ	270KΩ	Grd

Figure 6-2. R-104 Receiver Resistance Measurement Chart

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V-201 6U8A	500KΩ	75KΩ	400KΩ	0Ω	0Ω	200KΩ	20Ω	340Ω	80KΩ

Figure 6-3. M-136 VFO Resistance Measurement Chart

Tube No.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
V-1 6CD6	-2.2V	Grd	Grd	6.3V AC	235V	140V	Grd
V-2 6AH6	-5.5V	Grd	6.3V AC	Grd	240V	160V	.7V
V-3 6BE6	-1.3V	Grd	Grd	6.3V AC	240V	110V	-12.5V
V-4 6BE6	-3.8V	Grd	6.3V AC	Grd	240V	100V	-1.3V
V-5 6BA6	-1.3V	Grd	6.3V AC	Grd	230V	100V	Grd
V-6 6BA6	-1.3V	Grd	Grd	6.3V AC	230V	100V	Grd
V-7 6AT6	0	1.6V	6.3V AC	Grd	1.1V	-1.3V	150
V-8 6BE6	0	24.0V	Grd	6.3V AC	250V	250V	0
V-9 6AQ5	0	11.6V	Grd	6.3V AC	230V	250V	0
V-10 6DC6	-42.0V	Grd	Grd	6.3V AC	180V	100V	Grd

Figure 6-4. R-104 Receiver DC Voltage Chart

IST IF AMPL
6BA6
V5
XV5

2ND IF AMPL
6BA6
V6
XV6

AM DET / IST AUDIO
6AT6
V7
XV7

AUDIO OUTPUT
6AQ5
V9
XV9

BAND SWITCH SWI CRYSTAL FREQUENCY TABLE

POSITION	CRYSTAL FREQ	RCVR INPUT FREQ
1A	6.455	3.4 - 3.6MC
2A	6.655	3.6 - 3.8MC
3A	6.855	3.8 - 4.0MC
1B	10.055	7.0 - 7.2MC
2B	10.255	7.2 - 7.4MC
1C	17.055	14.0 - 14.2MC
2C	17.255	14.2 - 14.4MC
3C	17.855	14.8 - 15.0MC
1D	12.0275	21.0 - 21.2 MC
2D	12.1275	21.2 - 21.4 MC
3D	12.2275	21.4 - 21.6 MC
1E	15.7775	28.5 - 28.7MC
2E		
3E		

Figure 6-1. R-104 Receiver Schematic (Sheet 1 of 2)

IST IF AMPL
6BA6
V5
XV5

2ND IF AMPL
6BA6
V6
XV6

AM DET / IST AUDIO
6AT6
V7
XV7

AUDIO OUTPUT
6AQ5
V9
XV9

T3
T4
T5
T6

C55 200
C56 200
C60 200
C61 280
C71 5000
C79 5000
C78 5000
C80 20UF
C65 100
C66 10
C68 10UF
C67 39
C70 1000
C77 330
C81B 30UF
C81A 20UF
C81C 10UF
C75 0.01UF
C72 470
C69 75
C76 1.0UF
C73 5000
C64 0.1UF
C85 3000 2KV
C86 3000 2KV
C82 0.1UF
C83 10UF
C84 10UF
C51 1000
C50 125
C53 0.01UF
C54 0.01UF
C57 0.01UF
C59 0.01UF
C62 1000
C63 0.025UF
C52 470

R27 33K
R30 33K
R34 3900
R36 470K
R35 39K
R37 39K
R38 1MEG
AF GAIN
R44 470K
R45 270 2W
R63 33
R23 82K
R24 56K
R28 1200
R29 10K
R31 1200
R32 8200
R61 220K
R33 2.7MEG
R39 33K
R40 47K
R42 18K 2W
R41 4700 1W
R43 100K
R59 270
R54 22K
R57 100K
R46 10 2W
R47 10K
R48 10K
R51 10K
RF GAIN
R52 33K
R49 1000
RF GAIN ADJ.
R50 22K
R25 4700

FL1 2.1KC
FL2 0.5KC
F1 1A
F6
CR1
CR2
CR4
CR5
CR3 F6

SW4A
SW4B
SW4C
SW4D
SW4E
SW4F
SW3B
SW3C
AM
SB
USB
CW
LSB
CAL
OFF
OPR
STBY

L12 12H
L10
L11
Y30 453.8KC
Y31 456.4KC
C87 25-280
C88 25-280

J5 PHONES
J2A 4Ω AUDIO
J2B RCVR MUTE
J6 POWER
600Ω BALANCED
QT
JIC
JIA
JIB

V5 V6 V7 V8
V10 V1 V3 V4
V2 V9
I1
I2
WHT
GRN
X

PRODUCT DETECTOR
6BE6
V8
XV8

VFO
B+
USB-LSB
GRD
FIL
TO J201 OF VFO
P4
FOR VFO CONNECTION, SEE FIGURE 6-1 (SHEET 2 OF 2)

BAND SWITCH SW1 CRYSTAL FREQUENCY TABLE

POSITION	CRYSTAL FREQ	RCVR INPUT FREQ
1A	6.455	3.4 - 3.6MC
2A	6.655	3.6 - 3.8MC
3A	6.855	3.8 - 4.0MC
1B	10.055	7.0 - 7.2MC
2B	10.255	7.2 - 7.4MC
1C	17.055	14.0 - 14.2MC
2C	17.255	14.2 - 14.4MC
3C	17.855	14.8 - 15.0MC
1D	12.0275	21.0 - 21.2 MC
2D	12.1275	21.2 - 21.4 MC
3D	12.2275	21.4 - 21.6 MC
1E	15.7775	28.5 - 28.7MC
2E		
3E		

Figure 6-1. R-104 Receiver Schematic (Sheet 1 of 2)

RF AMPL
6DC6
V1
XV1

IST MIXER
6BE6
V3
XV3

2ND MIXER
6BE6
V4
XV4

IST IF AMPL
6BA6
V5
XV5

2ND IF AMPL
6BA6
V6
XV6

RF TUNING

C8 3-12 10(E)
C7 5-25 15(D)
C5 39
C6 8-50 20(C)
C3 150
C4 8-50 40(B)
C1 500
C2 8-50 80(A)
SW1A
T1
R55 82K
C9 100
R1 2.7MEG
R56 82K
L2
C25 3-12 10(E)
C24 5-25 15(D)
C22 39
C23 8-50 20(C)
C20 150
C21 8-50 40(B)
C18 500
C19 8-50 80(A)
SW1B
R6 33K
C15 0.01UF
C16 0.01UF
R7 1200 1W
M1 "S" METER
R8 100
R9 1500
R10 150K 2W
"S" METER ADJ
C17 0.01UF
J2C ANTENNA
C14 1
C10 330
R58 10K
BAND SWITCH
C26 10
C27 62
R12 33K
C30 0.01UF
R11 68K
C28 1000
R14 18K 2W
R13 22K
C29 330
C31 0.01UF
R15 1200
T2
C33 1.5
C32 47
C34 47
L1
C35 1.5
C36 47
C37 1000
R16 47K
R62 33K
C39 0.025UF
R18 18K 2W
C40 0.025UF
R17 22K
C45 84
C38 330
C90 150
L13 47
J4 VFO OUTPUT
SW4A
C48 1000
C49 150
L4 3MH
R19 1200
C41 0.01UF
AM
LSB
USB
CW
FL1 2.1KC
FL2 0.5KC
SW4B
C51 1000
C50 125
C52 470
T3
C55 200
C56 200
R27 33K
C53 0.01UF
R23 82K
C54 0.01UF
C57 0.01UF
R24 56K
R28 1200
R29 10K
T4
C60 200
C61 280
R30 33K
C58 0.01UF
C59 0.01UF
R32 8200
C62 1000
C63 0.025UF
R31 1200
R25 4700
TO J201 OF VFO
P4
VFO
B+
USB-LSB
GRD
FIL
X
PRODUCT DETECTOR
6BE6
V8
XV8
C69 75
SW4
Y30 453.8KC
Y31 456.4KC
L10
L11
C87 25-280
C88 25-280

SW3A
CAL
OFF
STBY
OPR
R5 560
R2 150K
XTAL CAL
6DC6
V10
XV10
100KC ADJ C11 5-25
Y29 100KC
R3 100K
C13 0.025UF
R4 1.5M
C12 280
SW2
AMAT
SPEC
Y1 Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9 Y10 Y11 Y12 Y13 Y14
Y15 Y16 Y17 Y18 Y19 Y20 Y21 Y22 Y23 Y24 Y25 Y26 Y27 Y28
SWIC
SWID
SWIE
1A 2A 3A 1B 2B 1C 2C 3C 1D 2D 1E 2E 3E
AMATEUR CRYSTALS
SPECIAL FREQ. CRYSTALS (NOT SUPPLIED)

HF XTAL OSC
6AH6
V2
XV2
R53 1500
R21 39K
C46 5000
C42 10
C43 280
R20 33K
L3 3MH
XTAL OSC OUTPUT
J3 P3
C44 470
R22 560
C47 0.025UF
C91 0.01UF
R60 1200
10(E) 15(D) 20(C) 40(B) 80(A)
L9 L8 L7 L6 L5
C89 4.7

BAND SWITCH SW1 CRYSTAL FREQUENCY TABLE

POSITION	CRYSTAL FREQ	RCVR INPUT FREQ
1A	6.455	3.4- 3.6MC
2A	6.655	3.6- 3.8MC
3A	6.855	3.8- 4.0MC
1B	10.055	7.0- 7.2MC
2B	10.255	7.2- 7.4MC
1C	17.055	14.0-14.2MC
2C	17.255	14.2-14.4MC
3C	17.855	14.8-15.0MC
1D	12.0275	21.0-21.2 MC
2D	12.1275	21.2-21.4 MC
3D	12.2275	21.4-21.6 MC
1E	15.7775	28.5-28.7MC
2E		
3E		

FOR VFO CONNECTION, SEE FIGURE 6-1 (SHEET 2 OF 2)

EXTERNAL P.S. 12V
EXTERNAL P.S. 24V. NOT SUPPLIED
INTERNAL A.C.
EXTERNAL P.S. 6V.

1	GROUND
2	24 V. FIL
3	12 V. FIL
4	6 V. FIL
5	6.3V. A.C.
6	6 V. FIL
7	250V B+
8	GROUND
9	50V BIAS
10	A.C.
11	A.C. SW
12	SW.

FIL GRD B+ 250V GRD PS SW BIAS -50V 12V
330 1W
FIL GRD B+ 250V GRD PS SW BIAS -50V 24V
115 V.A.C.
FIL GRD 6.3V B+ 250V GRD PS SW BIAS -50V

NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001
2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH
3- FOR PARTS LIST SEE P.L.-R104-0-0A

R-104 RCVR

RF AMPL
6DC6
V1
XV1

IST MIXER
6BE6
V3
XV3

2ND MIXER
6BE6
V4
XV4

IST IF AMPL
6BA6
V5
XV5

2ND IF AMPL
6BA6
V6
XV6

RF TUNING

BAND SWITCH

J2C ANTENNA

J4 VFO OUTPUT

"S" METER

"S" METER ADJ

SWIA SWIB SWIC SWID SWIE

SW2 AMAT SPEC

SW3A CAL OFF OPR STBY

SW4A AM LSB USB CW

FL1 2.1KC

FL2 0.5KC

T1 T2 T3 T4

L1 L2 L3 L4 L5 L6 L7 L8 L9 L10 L11 L12 L13

XTAL CAL
6DC6
V10
XV10

100KC ADJ C11 5-25

Y29 100KC

HF XTAL OSC
6AH6
V2
XV2

XTAL OSC OUTPUT J3 P3

AMATEUR CRYSTALS

SPECIAL FREQ. CRYSTALS (NOT SUPPLIED)

BAND SWITCH CRYSTAL FREQUENCY TABLE
SW1

POSITION	CRYSTAL FREQ	RCVR INPUT FREQ
1A	6.455	3.4 - 3.6 MC
2A	6.655	3.6 - 3.8 MC
3A	6.855	3.8 - 4.0 MC
1B	10.055	7.0 - 7.2 MC
2B	10.255	7.2 - 7.4 MC
1C	17.055	14.0 - 14.2 MC
2C	17.255	14.2 - 14.4 MC
3C	17.855	14.8 - 15.0 MC
1D	12.0275	21.0 - 21.2 MC
2D	12.1275	21.2 - 21.4 MC
3D	12.2275	21.4 - 21.6 MC
1E	15.7775	28.5 - 28.7 MC
2E		
3E		

FOR VFO CONNECTION, SEE FIGURE 6-1 (SHEET 2 OF 2)

TO J201 OF VFO

VFO B+ USB-LSB GRD FIL X

PRODUCT DETECTOR
6BE6
V8
XV8

Y30 453.8KC

Y31 456.4KC

1	GROUND
2	24 V. FIL
3	12 V. FIL
4	6 V. FIL
5	6.3V. A.C.
6	6 V. FIL
7	250V B+
8	GROUND
9	50V BIAS
10	A.C.
11	A.C. SW
12	SW.

EXTERNAL P.S. 12V.

EXTERNAL P.S. 24V. NOT SUPPLIED

INTERNAL A.C.

EXTERNAL P.S. 6V.

115 V.A.C.

NOTES

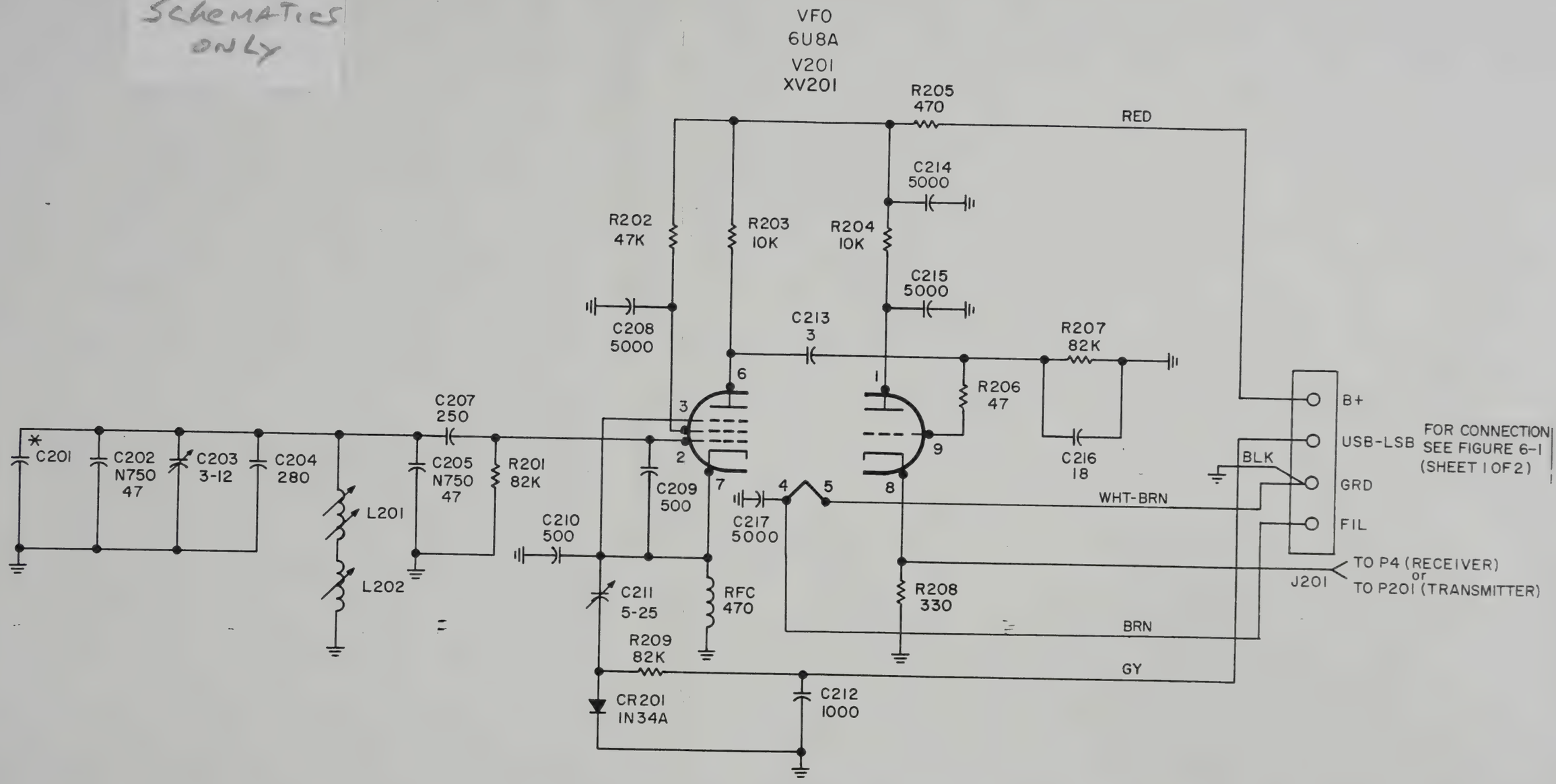
1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001

2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH

3- FOR PARTS LIST SEE P.L.-R104-0-0A

R-104 RECV'R

VARIOUS REL SCHEMATICS ONLY



NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001

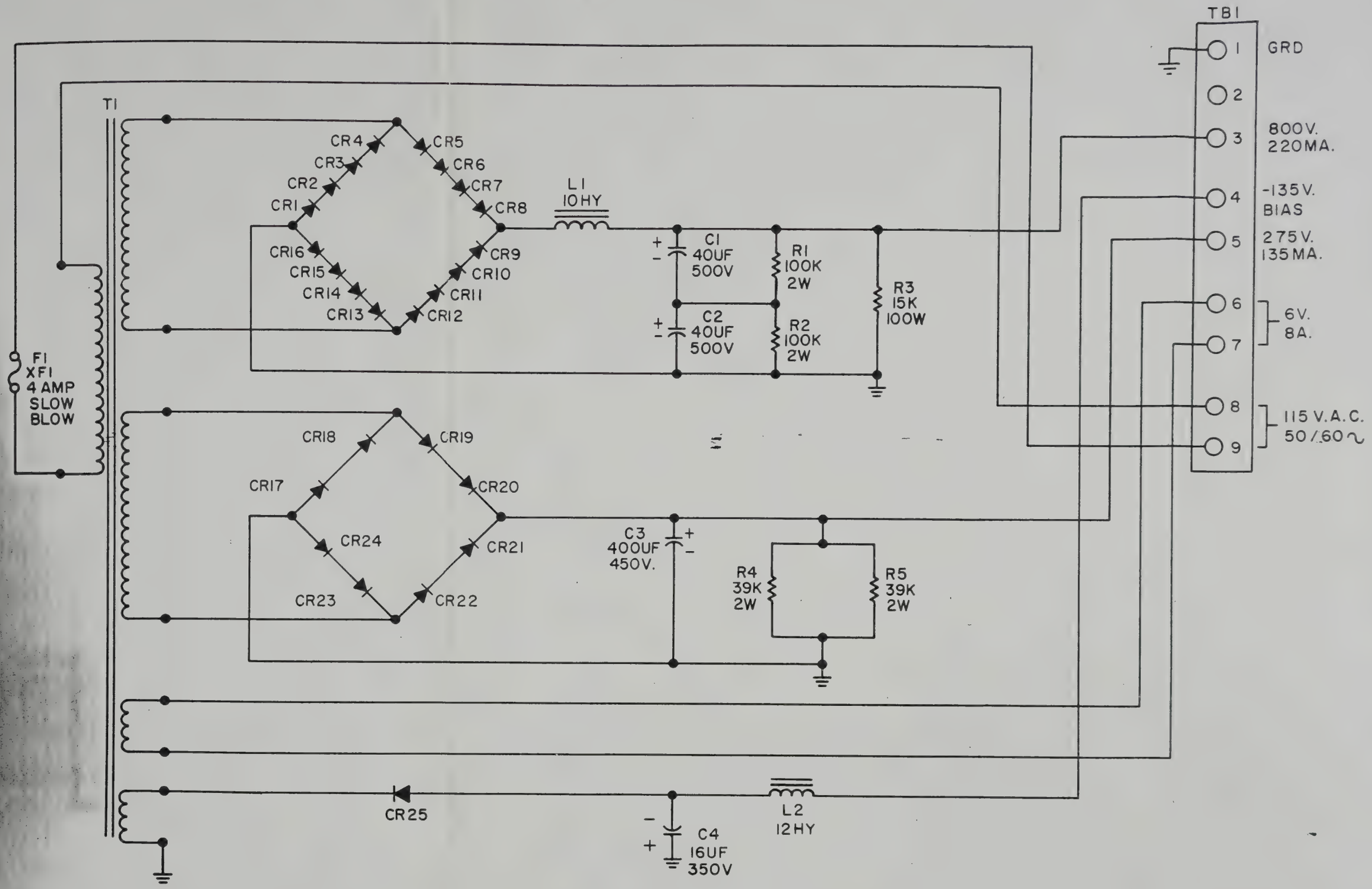
2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH

3- ITEM MARKED WITH (*) WAS ADDED IN TEST.

4- FOR PARTS LIST SEE P.L.-M-136-0-0A

M-136 VARIABLE FREQUENCY OSCILLATOR

Figure 6-1. T-102 Transmitter Schematic (Sheet 2 of 2)



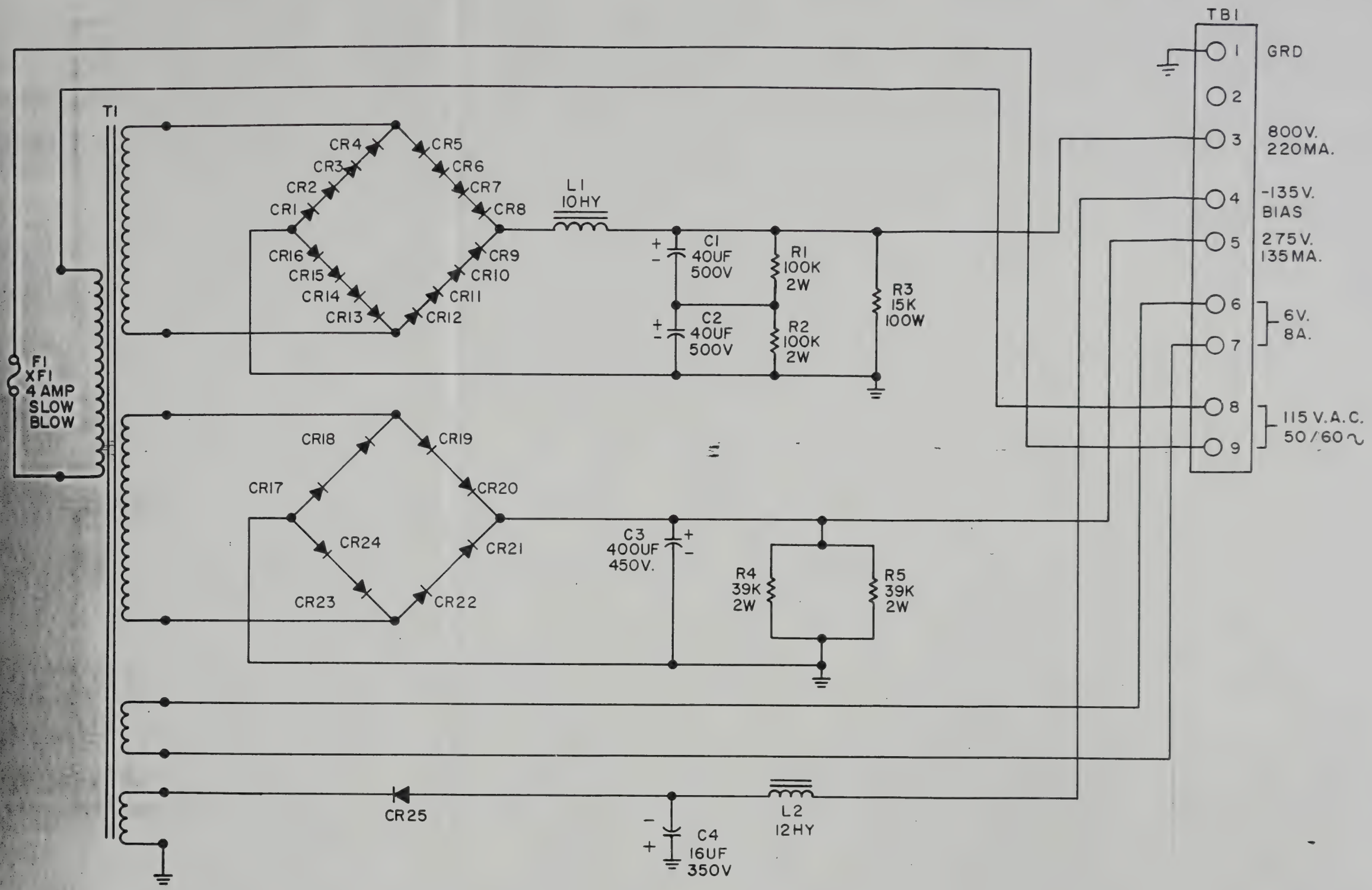
NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001

2- UNLESS OTHERWISE INDICATED:
   a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
   b. ALL CAPACITANCE VALUES ARE IN UUF
   c. ALL INDUCTANCE VALUE ARE IN UH

3- FOR PARTS LIST SEE P.L.-P109-0-0A

Figure 6-1. P-109 Power Supply Schematic



NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001

2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH

3- FOR PARTS LIST SEE P.L.-P109-0-0A

Figure 6-1. P-109 Power Supply Schematic

BAND SWITCH SW3 POSITION	CRYSTAL FREQ	XMTR OUTPUT FREQ
1A	6.455	3.4 - 3.6 MC
2A	6.655	3.6 - 3.8 MC
3A	6.855	3.8 - 4.0 MC
1B	10.055	7.0 - 7.2 MC
2B	10.255	7.2 - 7.4 MC
1C	17.055	14.0 - 14.2 MC
2C	17.255	14.2 - 14.4 MC
3C		
1D	12.0275	21.0 - 21.2 MC
2D	12.1275	21.2 - 21.4 MC
3D	12.2275	21.4 - 21.6 MC
1E	13.7775	28.5 - 28.7 MC
2E		
3E		

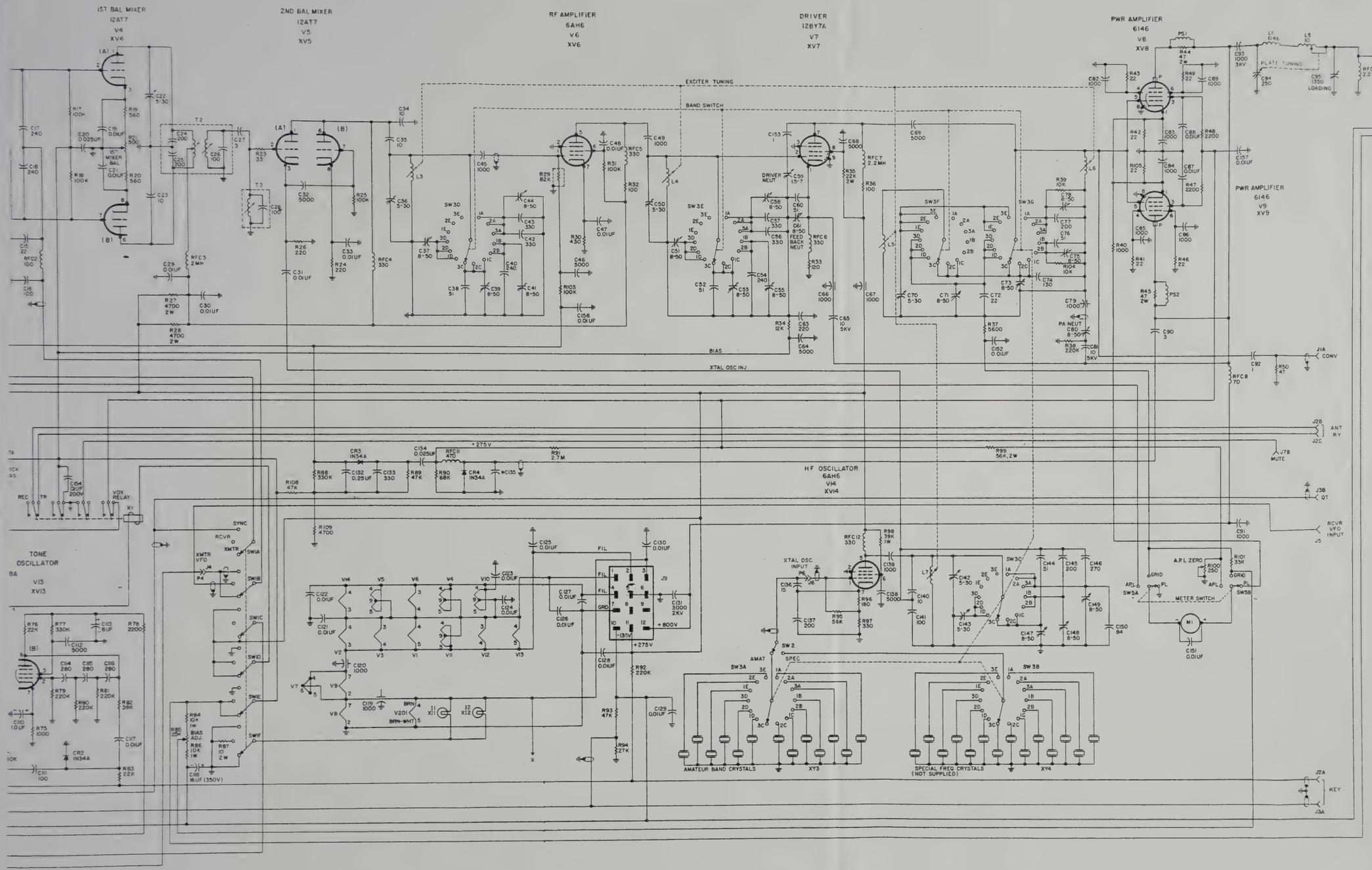
CRYSTAL FREQUENCY TABLE

(P9) POWER PLUG WIRING FOR 6V, 12V OR 24V FIL SUPPLY

NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT M=MILLI=0.001 S=SECOND U=MICRO=0.000001
2- UNLESS OTHERWISE INDICATED:
a ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b ALL CAPACITANCE VALUES ARE IN UUF
c ALL INDUCTANCE VALUE ARE IN UH
3- DIRECTIONAL ARROW AT CONTROLS INDICATES CLOCKWISE ROTATION, VIEWED FROM SHAFT (KNOB) END
4- FOR PARTS LIST SEE PL -T102-0-04
5- RELAYS SHOWN IN TRANSMIT POSITION (ENERGIZED)
6- ITEM MARKED WITH (*) WAS ADDED IN TEST

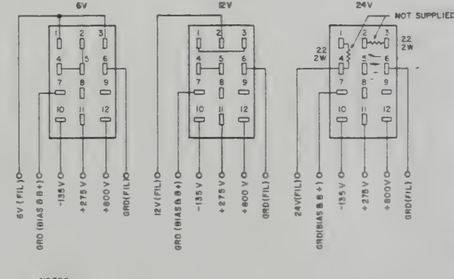
Figure 6-1. T-102 Transmitter Schematic (Sheet 1 of 2)



BAND SWITCH SW3 — CRYSTAL FREQUENCY TABLE

POSITION	CRYSTAL FREQ	XMTR OUTPUT FREQ
1A	6.455	3.4- 3.6 MC
2A	6.655	3.6- 3.8 MC
3A	6.855	3.8- 4.0 MC
1B	10.055	7.0- 7.2 MC
2B	10.255	7.2- 7.4 MC
1C	17.055	14.0-14.2 MC
2C	17.255	14.2-14.4 MC
3C		
1D	12.0275	21.0-21.2 MC
2D	12.1275	21.2-21.4 MC
3D	12.2275	21.4-21.6 MC
1E	15.7775	28.5-28.7 MC
2E		
3E		

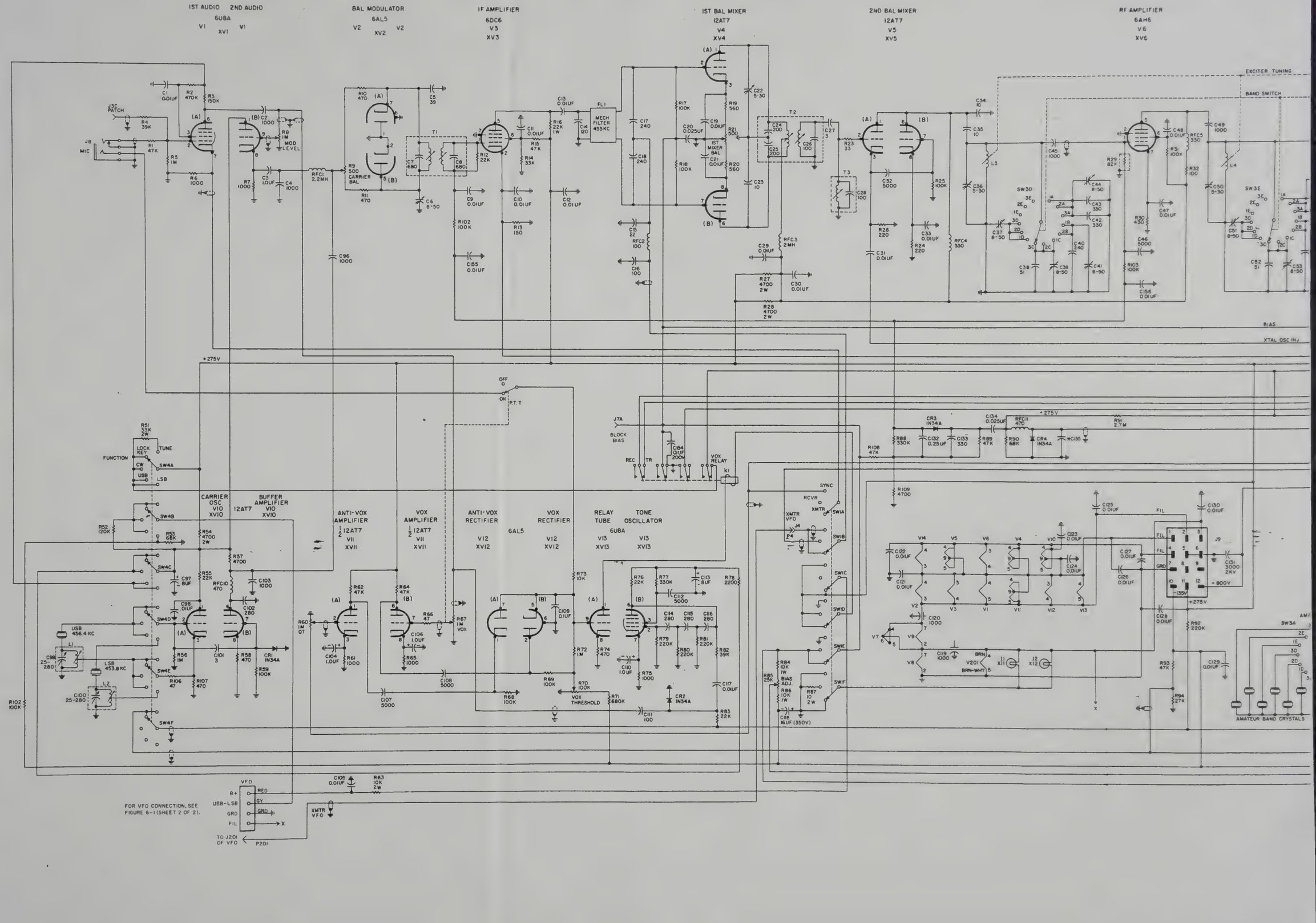
(P9) POWER PLUG WIRING FOR 6V, 12V OR 24V FIL SUPPLY



NOTES

1- K=KILO=1,000 MEG=1,000,000 F=FARAD H=HENRY W=WATT
M=MILLI=0.001 S=SECOND U=MICRO=0.000001
2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH
3- DIRECTIONAL ARROW AT CONTROLS INDICATES CLOCKWISE ROTATION, VIEWED FROM SHAFT (KNOB) END
4- FOR PARTS LIST, SEE P.L. -T102-0-09
5- RELAYS SHOWN IN TRANSMIT POSITION (ENERGIZED)
6- ITEM MARKED WITH (*) WAS ADDED IN TEST

Figure 6-1. T-102 Transmitter Schematic (Sheet 1 of 2)


1ST AUDIO 2ND AUDIO
6U8A
V1 XV1 V1
BAL MODULATOR
6AL5
V2 XV2 V2
IF AMPLIFIER
6DC6
V3 XV3
1ST BAL MIXER
12AT7
V4 XV4
2ND BAL MIXER
12AT7
V5 XV5
RF AMPLIFIER
6AH6
V6 XV6
EXCITER TUNING
BAND SWITCH
230 PATCH
J8 MIC
MECH FILTER 455KC
FL1
T1
T2
T3
MOD LEVEL
CARRIER BAL
+275V
OFF
ON
PT T
J7A
BLOCK BIAS
REC TR
VOX RELAY
K1
BIAS
XTAL OSC INJ
CARRIER OSC V10 XV10
12AT7
BUFFER AMPLIFIER V10 XV10
ANTI-VOX AMPLIFIER 1/2 12AT7 V11 XV11
VOX AMPLIFIER 1/2 12AT7 V11 XV11
ANTI-VOX RECTIFIER 6AL5 V12 XV12
VOX RECTIFIER V12 XV12
RELAY TUBE 6UBA V13 XV13
TONE OSCILLATOR V13 XV13
FUNCTION
LOCK KEY
TUNE
CW
USB
LSB
SW4A
SW4B
SW4C
SW4D
SW4E
SW4F
USB 456.4 KC
LSB 453.8 KC
VOX THRESHOLD
SYNC
RCVR
XMTR
XMTR VFO
SW1A
SW1B
SW1C
SW1D
SW1E
SW1F
FIL
GRD
+800V
-135V
AMATEUR BAND CRYSTALS
VFO
B+
USB-LSB
GRD
FIL
RED
GY
GRD
X
TO J201 OF VFO
P201
XMTR VFO
FOR VFO CONNECTION, SEE FIGURE 6-1 (SHEET 2 OF 2).

IST AUDIO 6U8A V1 XV1 — 2ND AUDIO V1

BAL MODULATOR 6AL5 V2 XV2 — V2

IF AMPLIFIER 6DC6 V3 XV3

IST BAL MIXER 12AT7 V4 XV4

2ND BAL MIXER 12AT7 V5 XV5

RF AMPLIFIER 6AM6 V6 XV6

EXCITER TUNING

BAND SWITCH

J3C PATCH

J8 MIC

R1 47K · R2 470K · R3 150K · R4 39K · R5 1M · R6 1000 · R7 1000 · R8 1M MOD LEVEL

C1 0.01UF · C2 1000 · C3 .1UF · C4 1000

T1

RFC1 2.2MH · C96 1000

R9 500 CARRIER BAL · R10 470 · R11 470 · C5 39 · C6 8-50 · C7 680 · C8 680

C9 0.01UF · C10 0.01UF · C11 0.01UF · C12 0.01UF · C13 0.01UF · C14 120

R12 22K · R13 150 · R14 33K · R15 47K · R16 22K 1W · R102 100K · C155 0.01UF

FL1 MECH FILTER 455KC

C15 22 · C16 100 · RFC2 100 · C17 240 · C18 240

R17 100K · R18 100K · R19 560 · R20 560 · R21 500 · C19 0.01UF · C20 0.025UF · C21 0.01UF · IST MIXER BAL · C22 5-30 · C23 10

T2 · C24 200 · C25 200 · C26 100 · C27 3

T3 · C28 100

C29 0.01UF · RFC3 2MH · R27 4700 2W · R28 4700 2W · C30 0.01UF

R23 33 · C31 0.01UF · C32 5000 · R25 100K · R26 220 · C33 0.01UF · R24 220 · RFC4 330

C34 10 · C35 10 · C36 5-30 · L3

SW3D · SW3C · SW3B · SW3A · C37 8-50 · C38 51 · C39 8-50 · C40 240 · C41 8-50 · C42 330 · C43 330 · C44 8-50 · C45 1000

R29 82K · R30 430 · C46 5000 · R103 100K · C156 0.01UF · C47 0.01UF · R31 100K · C48 0.01UF · RFC5 330 · R32 100

C49 1000 · C50 5-30 · L4 · SW3E · C51 8-50 · C52 51 · C53 8-50

BIAS

XTAL OSC INJ.

+275V

OFF · ON · P.T.T.

J7A BLOCK BIAS · REC · TR · VOX RELAY · K1

R51 33K 2W · LOCK KEY · TUNE · FUNCTION · CW · USB · LSB · SW4A

CARRIER OSC V10 XV10 — BUFFER AMPLIFIER 12AT7 V10 XV10

ANTI-VOX AMPLIFIER 1/2 12AT7 V11 XV11 — VOX AMPLIFIER 1/2 12AT7 V11 XV11

ANTI-VOX RECTIFIER 6AL5 V12 XV12 — VOX RECTIFIER V12 XV12

RELAY TUBE 6U8A V13 XV13 — TONE OSCILLATOR V13 XV13

R52 120K · R53 68K · R54 4700 2W · R55 22K · R57 4700 · RFC10 470 · C103 1000 · C102 280

SW4B · SW4C · SW4D · SW4E · SW4F

C97 8UF · C98 .01UF · C101 3 · CR1 1N34A · R58 470 · R59 100K

USB 456.4 KC · LSB 453.8 KC · L1 · L2 · C98 25-280 · C100 25-280 · R56 1M · R106 47 · R107 470

R102 100K

R60 1M OT · R61 1000 · C104 1.0UF · R62 47K · R64 47K · R65 47 · R66 100K · R67 1M VOX · C106 1.0UF · R65 1000 · C107 5000 · C108 5000

C109 0.1UF · R69 100K · R70 100K VOX THRESHOLD · R71 680K · C111 100 · CR2 1N34A · R72 1M · R74 470 · R73 10K · C110 1.0UF · R75 1000 · R76 22K · R77 330K · C113 8UF · C112 5000 · R78 2200 · C114 280 · C115 280 · C116 280 · R79 220K · R80 220K · R81 220K · R82 39K · C117 0.01UF · R83 22K

R84 10K 1W · R85 25K · BIAS ADJ. · R86 10K 1W · R87 10 2W · C118 16UF (350V)

SYNC · RCVR · XMTR · XMTR VFO · J4 · SW1A · SW1B · SW1C · SW1D · SW1E · SW1F

R108 47K · R109 4700 · R91 2.7M

CR3 1N34A · C132 0.25UF · C133 330 · C134 0.025UF · RFC11 470 · R89 47K · R90 68K · CR4 1N34A · C135

C125 0.01UF · C130 0.01UF · FIL · J9 · C127 0.01UF · C126 0.01UF · C131 3000 2KV · +800V · -135V · +275V

V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12 V13 V14

C121 0.01UF · C122 0.01UF · C123 0.01UF · C124 0.01UF · C120 1000 · C119 1000 · BRN · BRN-WHT · V201 · X11 · X12 · X

C128 0.01UF · R92 220K · R93 47K · C129 0.01UF · R94 27K

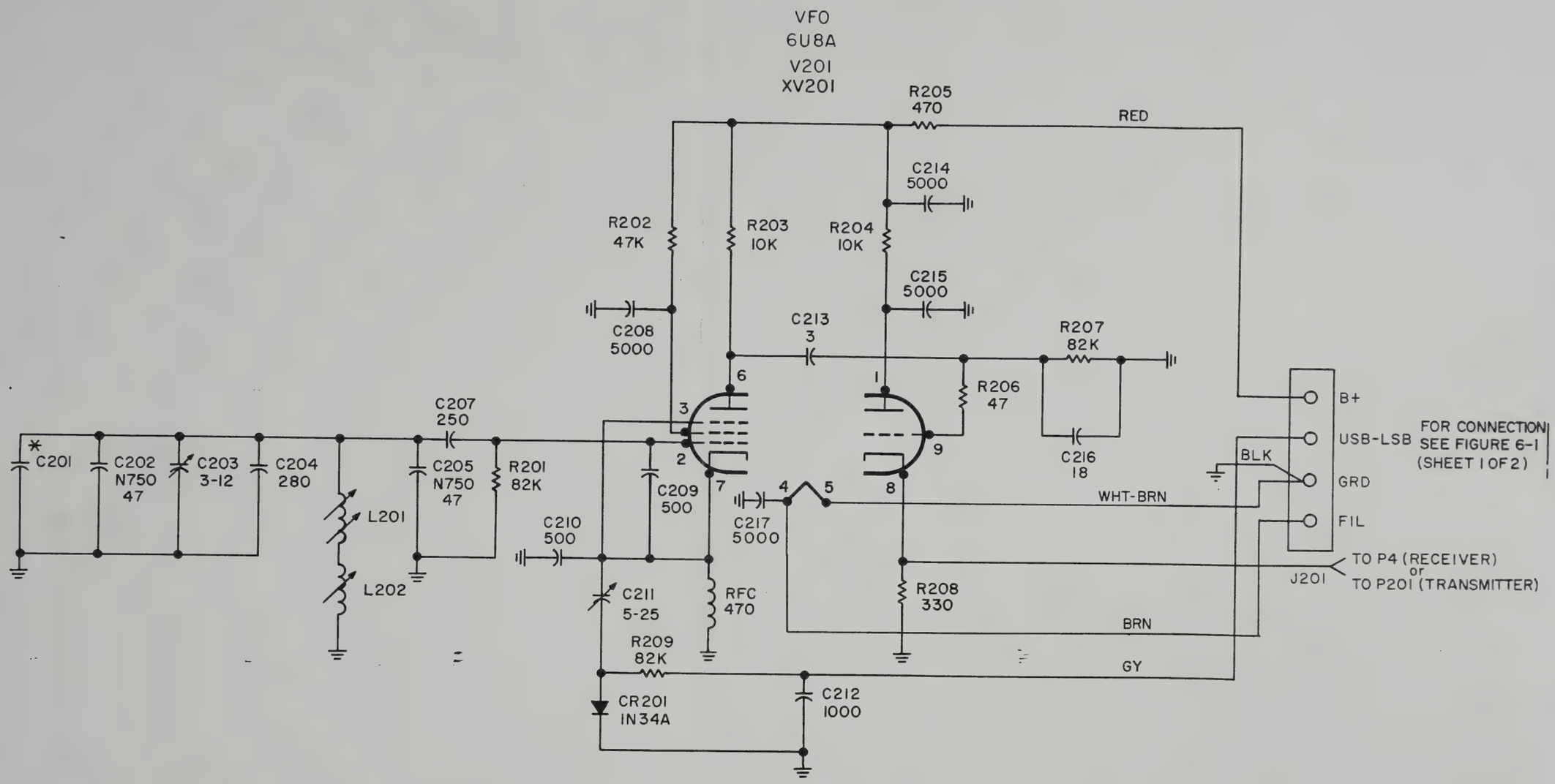
SW3A · AMATEUR BAND CRYSTALS

R88 330K · C132 0.25UF · C133 330 · R89 47K · R90 68K · CR4 1N34A · C135

VFO · B+ · USB-LSB · GRD · FIL · RED · GY · GRD · X · TO J201 OF VFO · P201

FOR VFO CONNECTION, SEE FIGURE 6-1 (SHEET 2 OF 2).

C105 0.01UF · R63 10K 2W · XMTR VFO



NOTES

1- K = KILO = 1,000 MEG = 1,000,000 F = FARAD H = HENRY W = WATT
M = MILLI = 0.001 S = SECOND U = MICRO = 0.000001

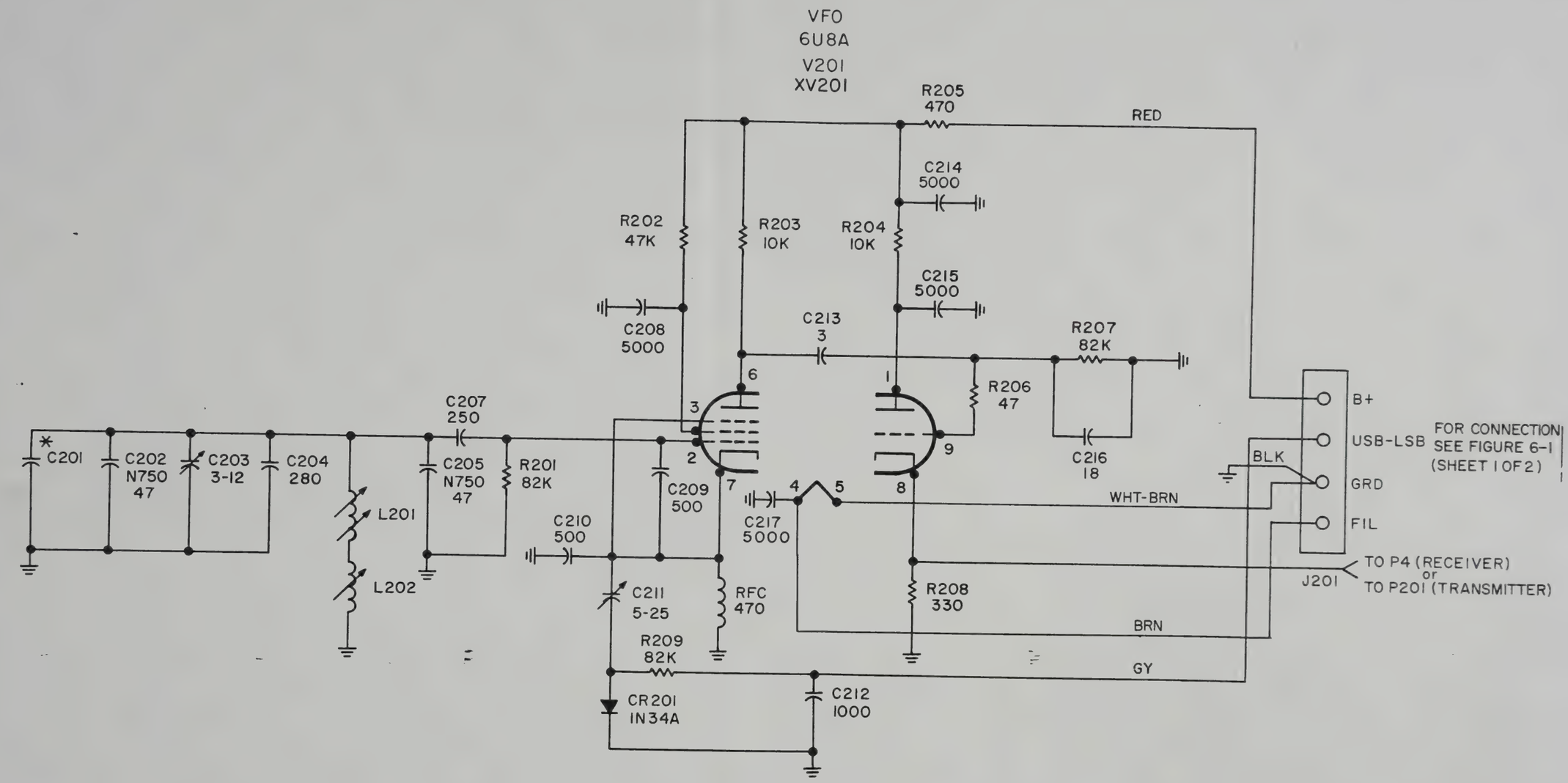
2- UNLESS OTHERWISE INDICATED:
a. ALL RESISTANCE VALUES ARE IN OHMS, 1/2 WATT
b. ALL CAPACITANCE VALUES ARE IN UUF
c. ALL INDUCTANCE VALUE ARE IN UH

3- ITEM MARKED WITH (*) WAS ADDED IN TEST.

4- FOR PARTS LIST SEE P.L.-M-136-0-0A

M-136 VARIABLE FREQUENCY OSCILLATOR

Figure 6-1. R-104 Receiver Schematic (Sheet 2 of 2)



NOTES

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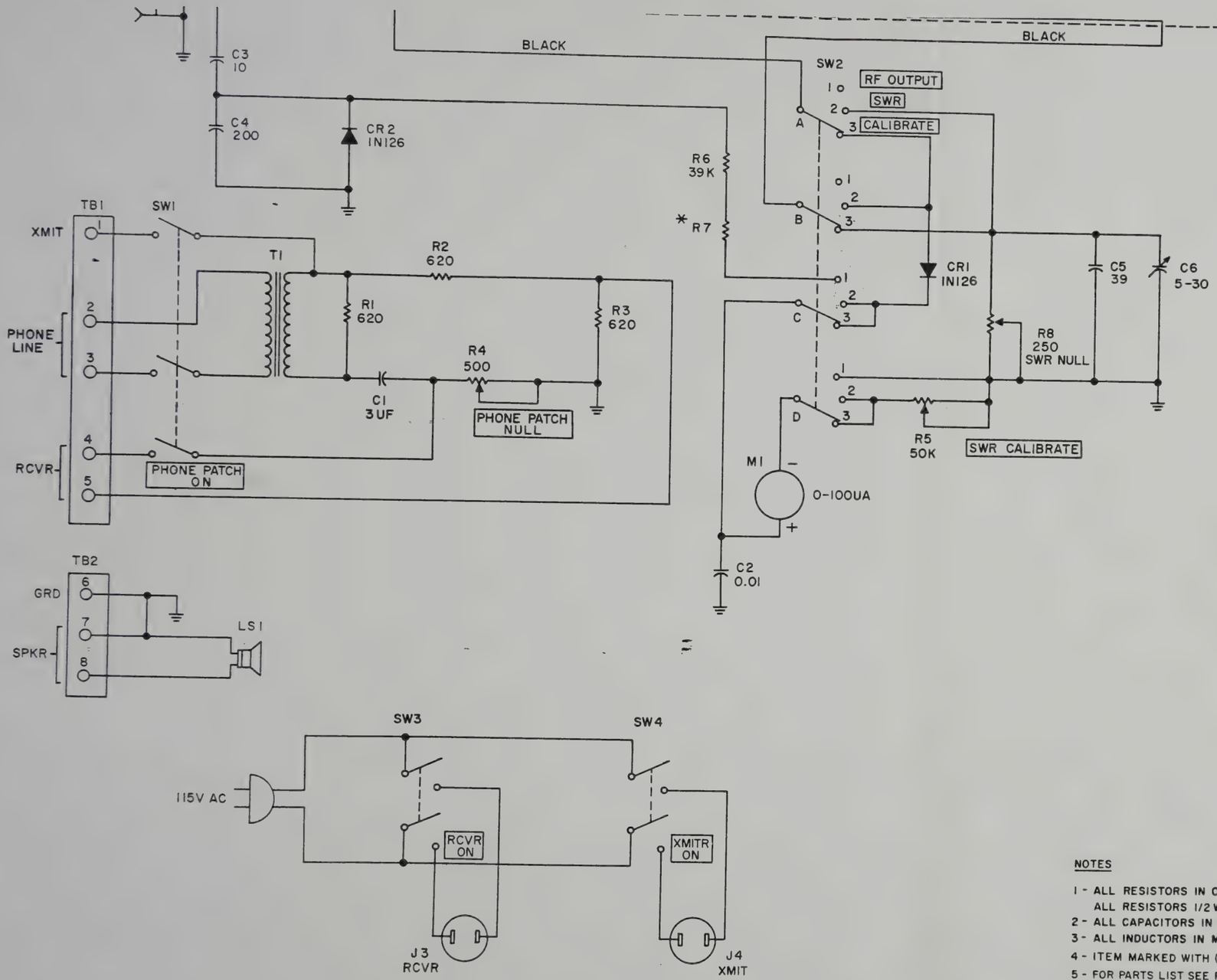
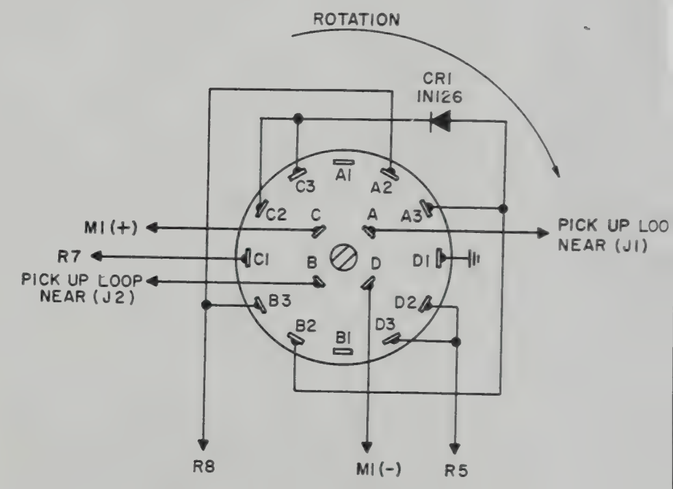
c. ALL INDUCTANCE VALUE ARE IN UH
3- ITEM MARKED WITH (*) WAS ADDED IN TEST.
4- FOR PARTS LIST SEE P.L.-M-136-0-0A

M-136 VARIABLE FREQUENCY OSCILLATOR

Figure 6-1. R-104 Receiver Schematic (Sheet 2 of 2)



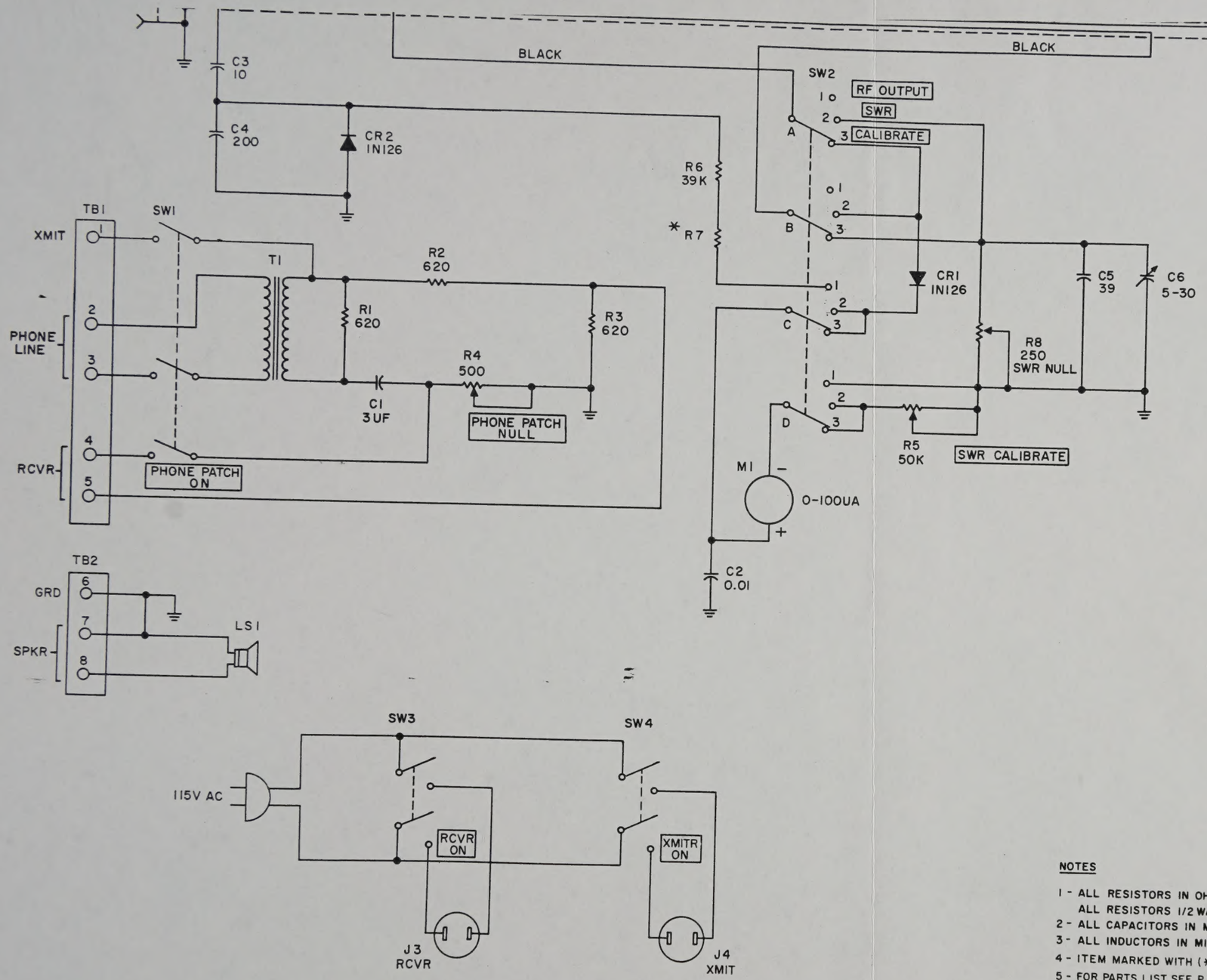


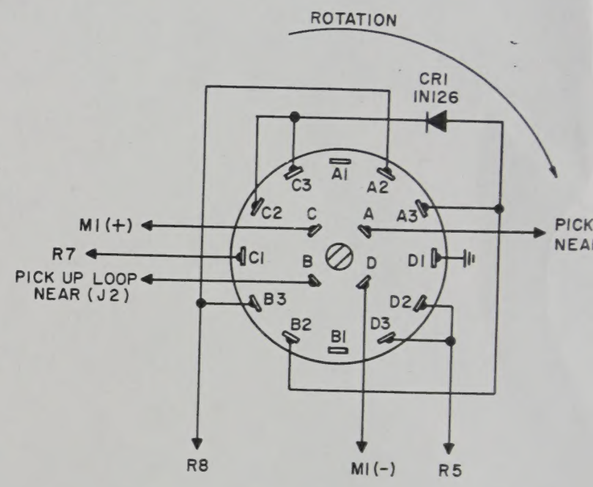
REAR VIEW OF SWITCH SW2

NOTES

1 - ALL RESISTORS IN OHMS UNLESS FOLLOWED BY K(1,000) OR M(1,000,000). ALL RESISTORS 1/2 WATT EXCEPT AS NOTED.
2 - ALL CAPACITORS IN MICRO-MICROFARADS UNLESS FOLLOWED BY UF(MICROFARADS).
3 - ALL INDUCTORS IN MICROHENRIES UNLESS FOLLOWED BY MH(MILLIHENRIES) OR H(HENRIES).
4 - ITEM MARKED WITH (*) WAS ADDED IN TEST.
5 - FOR PARTS LIST SEE P.L.-M-135-0-0A
6 - DIRECTIONAL ARROW AT CONTROLS INDICATES CLOCKWISE ROTATION, VIEWED FROM SHAFT (KNOB) END

Figure 6-1. M-135 Control Unit Schematic





REAR VIEW OF SWITCH SW2

NOTES

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3 - ALL INDUCTORS IN MICROHENRIES UNLESS FOLLOWED BY MH(MILLIHENRIES) OR H(HENRIES).
4 - ITEM MARKED WITH (*) WAS ADDED IN TEST.
5 - FOR PARTS LIST SEE P.L.-M-135-0-0A
6 - DIRECTIONAL ARROW AT CONTROLS INDICATES CLOCKWISE ROTATION, VIEWED FROM SHAFT (KNOB) END

Figure 6-1. M-135 Control Unit Schematic